Biennial Report of the Activities and Programs of the Montana Bureau of Mines and Geology July 1, 1999 – June 30, 2001

Science and Service for Montana

compiled by
the Staff of the Montana Bureau of Mines and Geology

Edmond Deal
Director and State Geologist

Open-File Report 419

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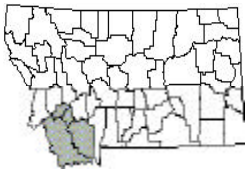

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2001

Cover: Brackett Creek Sill (Courtesy of Richard Berg, MBMG)

Brackett Creek sill is one of the more prominent of the many sills that form ridges surrounding the Crazy Mountains. These sills were formed when magma that cooled to form the core of the Crazy Mountains "squeezed out" between beds of sandstone. This magma, which cooled about 49 million years ago, formed a hard rock, somewhat resembling granite, but darker in color and containing much feldspar. Erosion of softer beds exposed sills such as this sill along Brackett Creek west of Clyde Park. This sill can be traced for six miles along a ridge that is about 30 feet thick, where Brackett Creek has eroded through it.

Contents

Director's Introduction

Edmond G. Deal, Ph.D.

Director and State Geologist

The Montana Bureau of Mines and Geology (MBMG) is a non-regulatory, applied-research and public service agency and is the state's geological survey. Established by the Montana Legislature in 1919 as a department of Montana Tech, MBMG is mandated to provide reliable and unbiased earth science information for the State of Montana. MBMG accomplishes its mission through the coordinated activities of its divisions: Research, Information Services, Computer Services, Analytical, and Administrative. Its scientists conduct studies across the entire state, dealing with the large, but largely unrecognized, role that geology plays in the daily lives of individuals. Geologic resources, particularly ground water, are critical; many communities are at risk from geologic hazards, some of our own making; environmental impacts, whether caused by industry, agriculture, or growing population centers must be resolved. MBMG provides extensive advisory, technical, and informational and educational services to the public and to other agencies in order to guide responsible development and protection of Montana's mineral, energy, and most importantly, water resources.

MBMG's staff comprises about 60 full-time research professionals and support staff, plus 20–25 students who work part time. The main office is located on the campus of Montana Tech of The University of Montana, and a smaller office is located on the Montana State University, Billings campus. The locations on the respective campuses provide synergies for cooperative research between MBMG staff and academic faculty through shared use of equipment and common interests and expertise. Student assistants gain first-hand practical experience in conducting applied research projects, as well as provide an inexpensive labor pool for accomplishing many routine duties. During the biennium, staff turnover has been low, and changes have been limited mostly to replacement of those few individuals who moved to other employment.

Funding for MBMG is provided through a combination of a biennial appropriation from the state, and research and service contracts with outside organizations. MBMG uses its state funding to maintain a core of basic programs that provide geological services and information that are the foundation of Bureau research, and additional investigations are conducted as outside funds permit. Many projects are conducted jointly with state, federal, or local agencies or organizations. Growth within MBMG has been limited to research areas supported by contracts and grants. Thus, newly identified research needs, such as coal-bed methane, can be investigated only by shifting personnel from other programs or obtaining outside funding. Over half of MBMG's research budget is derived from sources outside the state's general appropriation; likewise, less than half of the staff is supported by state funds. The State funding is highly leveraged. In the 2000 fiscal year, total expenditures (exclusive of the Ground Water Assessment Program) were $3,448,245. Of this, only $1,497,449 (43.4%) was from the state appropriation, and $1,950,796 (56.6%) was from contracts and

grants. Therefore, each state dollar generated an additional $1.30 to support Bureau programs.

During the two years that I have been director of MBMG, programs have been mildly reshaped to better meet demands as personnel and resources permit. Most notably, computers, and particularly the Internet, have made it easier and cheaper to disseminate information. MBMG is increasingly providing both reports and data digitally when it is feasible. GWIC (Ground-Water Information Center), which is the digital data base for MBMG's Ground-Water Assessment Program has been online since early 1999, and attracts an average of about 2,000 users per month. Geologic maps traditionally have been paper products; these are now being produced as high-quality digital products that can be easily produced as plot-on-demand products or transmitted digitally to those having the necessary facilities. Staff productivity remains high, as evidenced by publications and reports. Unfortunately, decreases in unrestricted budgets have required elimination of a very modest program for continuing education and professional development and have restricted much needed improvements to working spaces.

In the early part of the twentieth century, geologic activities in Montana, as in many other states, emphasized mapping and research that supported the extractive minerals industry, which drove the economic development of the state. Over the ensuing decades, however, the role of state geological surveys expanded in response to the needs of society, and the emphasis shifted to providing geological information that could be used to provide answers for environmental and social needs as well as economic needs. Today, as in the past, MBMG strives to respond to these needs through research and service, information, and education. In the following sections of this biennial report, short overviews of many of the diverse MBMG activities conducted during the past two years are provided. We hope that you will find this report informative, and if further information is desired, feel free to contact project leaders, MBMG's Publications Sales Office (406/496-4167), or log on to the MBMG web site (http://mbmgsun.mtech.edu).

Research Division

Wayne A. Van Voast
Division Chief

Introduction

Mineral and water resources across the state are directly touched by Bureau evaluations and mapping. Results of the work enhance the state's information base, encourage responsible development and environmental protection, and provide key assessments of current areas and levels of resource problems. The following pages highlight many of the Bureau's programs and projects, as topically arranged under broad categories. Parts of the state affected or involved are annotated for each project.

The Bureau's stellar geologic program, STATEMAP, progressed steadily across the state. Final results will include seamless, digital geologic maps for the entire state and a series of special maps that focus on areas of rapid urban growth. During the 1998–2000 biennium, large areas of new mapping were completed, and techniques of digitally producing the map products were refined and advanced.

As the Bureau's earthquake studies program continued its monitoring, more than 1,040 quakes having magnitudes less than 5.3 were located and catalogued. A recent expansion of the program onto the Flathead Indian Reservation has added much of northwestern Montana to the earthquake-monitoring network.

The ongoing Small Mine Operators Assistance Program and the Mineral Information and Statistics Program continued steadily, and a handbook on placer mining was nearly completed.

Work on industrial minerals was concentrated on talc and zeolites, and Montana vermiculites will be included in future studies.

Oil- and gas-related activities included continuation of a petroleum reservoir characterization in Blaine County. Geologic studies of the Crow and Northern Cheyenne Indian Reservations were also completed and may encourage exploration for oil and gas there.

The Bureau's attention to responsible development of Montana coal was advanced through several federally funded projects to catalogue coal data and evaluate resource availability and through initialization of a new project that will evaluate development of coal-bed methane.

Recognizing that more than 60% of Montanans rely on ground water for drinking, and that it is also the life-blood for agricultural and some industrial needs, the Bureau conducts numerous programs to evaluate ground water. One of the foremost, the Montana Groundwater Assessment Program, advanced strongly these past two years with completion of work for characterization of the Lower Yellowstone area and continuing of data collection in several other areas. Scheduled thus far are completion of the Lower Yellowstone report in December 1998, the Flathead area report in July 1999, the Middle Yellowstone report in July 2001, and the Lolo-Bitterroot report in July 2002. Included in the Assessment Program is the establishment of a state-wide ground-water monitoring program (now 80% completed), and companion studies of carbon and oxygen

isotopes to assess ground-water ages, recharge rates, and flow paths.

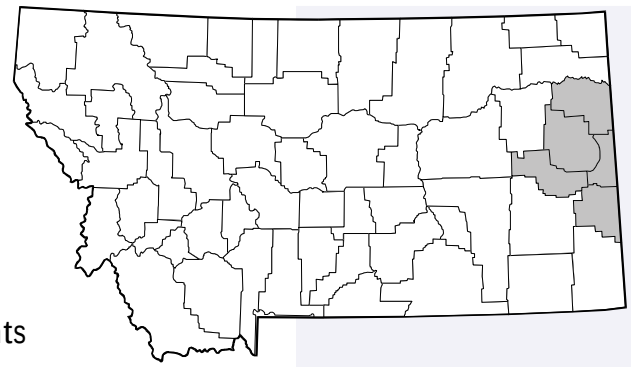
Concerns over development of Montana ground water near Yellowstone Park has promoted two programs conducted by the Bureau in cooperation with the National Park Service and the Montana Department of Natural Resources and Conservation. One is a program of well and spring inventory and baseline water sampling that was begun as part of a geothermal protection program for the park. The other is directed at water rights of the area, and is a detailed study of ground and surface water in the Soda Butte drainage northeast of the park.

As always, Bureau hydrogeologists are very active in assessments of ground-water occurrence and conditions. In 1999–2000, these programs included appraisals of ground-water conditions and quality in the Sweet Grass Hills and in the Red River watershed, and evaluations of ground-water/surface-water relationships and chronic streamflow shortages in the Big Hole basin, assessments of ground-water availability for the Pryor area, baseline data collection in the Bull Mountains area near Roundup, and hydrogeologic study and monitoring of aquifers used for irrigation in eastern Sheridan County.

Numerous ground-water evaluations pertinent to public health also are being performed by Bureau staff. Important to drinking water protection are the evaluations of ground-water supplies under the influence of surface water; local assistance to wellhead protection for community water systems; delineations of wellhead protection areas at rural schools, and evaluations of radon, pesticides, and septic nutrients in public ground-water supplies.

Superfund and related programs continued as water conditions in the abandoned workings of the Berkeley Pit and adjacent water levels were monitored. Nearby, at the Montana Pole Superfund site, a program to experiment with treatment of soils contaminated with diesel and chlorinated hydrocarbons was begun. Also related to mining: evaluations of zeolites for controlling heavy-metal concentrations in mine wastes, acid-mine drainage study near Stockett, water level and quality monitoring at southeastern Montana coal mines, evaluation of a proposed coal longwall mine near Roundup, assessments and inventory of abandoned mines on federal lands, cooperative work with Montana Department of Environmental Quality (formerly State Lands) on mine permitting, and natural resources damage assessment in the upper Clark Fork basin (through Montana Department of Justice) are all described on the following pages.

Geological Projects



Project Title: Geologic Mapping Program

Location: State Wide

Period of Project: Ongoing since 1986 in competitive cooperative programs with the U.S. Geological Survey; since 1992, under USGS's National Cooperative Geologic Mapping Program (NCGMP). The STATEMAP and EDMAP components of the NCGMP partially support field mapping by state geologists and graduate students, respectively.

Problem

A modern geologic map base for the state at a useful scale (minimum of 1:100,000) does not exist, although new information from many sources is available. The digital geologic map base being constructed in this project is essential to the effective conduct of many MBMG programs, including evaluation of ground-water, mineral, and fossil fuel resources; seismic hazards; radon contamination; abandoned and inactive mine status; and geothermal resources. Additionally, an adequate geologic base is essential for areas of the state that are undergoing rapid population growth without adequate information concerning slope stability, swelling clays, water resources, aquifer contamination, flood-prone areas, and sites of potentially economic materials.

Objectives

The objectives of the geologic mapping program are (1) to provide digitally based, accurate, updated geologic maps at the 1:100,000 scale for the entire state; (2) to prepare larger scale maps (1:48,000 or larger) for designated areas of rapid urban or rural growth. These maps reflect modern structural and stratigraphic concepts and include a significant amount of new mapping.

Approach

Geologic maps are prepared by (1) compiling all available geologic map information for the area, (2) field checking the compilation, and (3) conducting new field mapping and revision of earlier mapping. Data are integrated at the desired scale, the map is finalized through a strict review process, geologic data are entered in the MBMG geographic information system (GIS) data base, and the hard-copy products and digital data are made available to the public. Copies of many maps are submitted to the USGS in fulfillment of funding contracts. Most maps require two to three years to complete; seven Bureau geologists work part or full time on this program. In addition to digitally producing new geologic maps, geologists and GIS staff are bringing older, non-digital maps into digital form.

Work with Graduate Students

In addition to conducting its own geologic mapping, MBMG works each year with one or more graduate students doing field theses in Montana funded by the EDMAP component of the NCGMP. MBMG has responsibility for oversight of the work, and production of the student's final map.

Progress and Products during the 1999–2001 Biennium

The following geologic maps were completed between July 1, 1998, and June 30, 2000, and are available to the public:

At the 1:100,000 scale (30' x 60'): Malta, Glasgow, Great Falls South, Musselshell, Roundup, Big Timber, Livingston, Gardiner, Wallace, and Lima.

At the 1:24,000 scale: Harrison, Maltbys Mound, Elkhorn Mountains area, Dana Ranch, Conway Ridge, Millegan, Garrison, and Luke Mountain.

Plans for the 2001–2003 Biennium

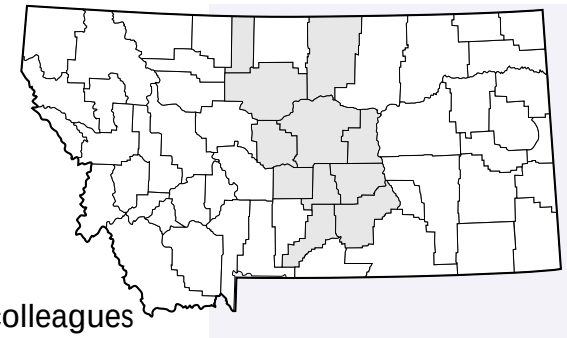
Field mapping will continue in several areas of the state, including work that will (1) complete our 1:100,000-scale coverage of the state east of 112° west longitude, (2) provide detailed geology for the Bitterroot valley and for Montana's common border with Yellowstone National Park, and (3) continue digitizing older maps.

STATEMAP Advisory Committee

Tim Bozorth, Bureau of Land Management
Mike Cannon, U.S. Geological Survey, WRD
Steve J. Czehura, Montana Resources, Inc.
Delwyn Gage, Consulting Geologist
Sid L. Groff, Former State Geologist of Montana
James W. Halvorson, Montana Board of Oil and Gas Conservation
David R. Lageson, Montana State University
Ian M. Lange, The University of Montana
Bonnie K. Lovelace, MT Dept. of Environmental Quality
John Montagne, Montata State University (emeritus)
James Shelden, U.S. Forest Service, Region 1
Wayne A. Wetzel, MT Dept. of Natural Resources & Conservation
Donald W. Wirth, Consulting Geologist

Project Title: Stratigraphic Research

Location: Central Montana (Liberty, Choteau, Fergus, Petroleum, Musselshell, Golden Valley, Wheatland, Yellowstone, Blaine, Stillwater, Judith Basin



Period of Project: Ongoing since 1992

Project Leader: Karen Porter

Project Staff: Bureau personnel and outside research colleagues

Funding Sources: Montana Bureau of Mines and Geology, U.S. Geological Survey

Problem

The occurrence and distribution of sedimentary rock units in the subsurface of central Montana is of interest because these rocks contain oil and natural gas in numerous fields throughout the Rocky Mountain and High Plains region from southern Colorado into Canada. Understanding how the rock units of central Montana relate to the same intervals elsewhere in the region will increase our ability to recognize stratigraphic details affecting the occurrence and trapping of productive hydrocarbons.

Objectives

The objective of the research is to develop models for improved prediction of the occurrence of oil and gas in the subsurface.

Approach

Detailed field studies are conducted on rock outcrops of those sedimentary rock intervals known to produce hydrocarbons in the subsurface. Important aspects of these outcrops are: specific rock types such as sandstones, shales, and limestones; thicknesses; vertical and lateral changes in the stratigraphic layers; and correlation of the units at one locality with those at another. Correlations are also made between the outcrops and existing well logs of drilled oil and/or water wells. These surface and subsurface correlations allow the geologist to make maps of the subsurface distribution of the rock types. The surface and subsurface information, when combined, lead to the development of a geologic model, that is, a three-dimensional picture of how these rocks were first laid down as sediment, then compressed into rock, and finally became hosts to oil and gas.

Progress during the 1999–2001 Biennium

Studies of the marine Lower Cretaceous rocks have led to development of models of these rocks as ancient marine deposits and of the ancient erosion surfaces that have modified these deposits. Ability to predict oil and gas occurrence in these intervals in the subsurface is improved.

Information Products during the 2001–2003 Biennium

Porter, K.W. 1998, Jurassic and Cretaceous outcrop equivalents of Shaunavon, Lower Mannville, and Bow Island/Viking reservoirs, North-central Montana: MBMG Special Publication 113, 29 p., 4 pl.

Porter, K.W., Dyman, T.S., Cobban, W.A., and Reinson, G.E. 1998, Post-Mannville/Kootenai Lower Cretaceous rocks and reservoirs, north-central Montana, southern Alberta, and Saskatchewan, *in* Christopher, C.E., Gilboy, C.F., Paterson, D.F., and Bend, S.L., eds., Eighth International

Williston Basin Symposium: Saskatchewan Geological Society Special Publication Number 13, p. 123–127.

Dyman, T.S., Porter, K.W., Tysdal, R.G., Cobban, W.A., and Obradovich, J.D., in press, Late Albian Blackleaf and Thermopolis-Muddy sequence in Southwest Montana, and correlation with time-equivalent strata in west-central Montana: Montana Geological Society Field Conference Guidebook.

Project Title: Geologic Research in Support of Mineral Resource Studies in Montana

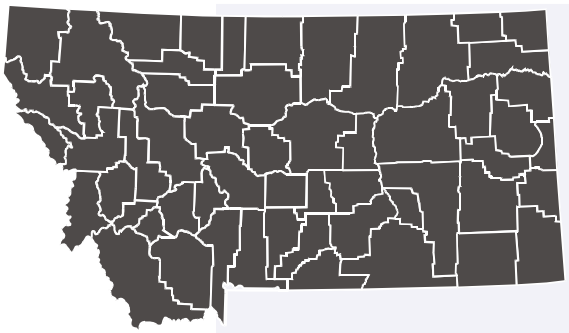
Location: State Wide

Period of Project: September 1999–September 2000

Project Leaders: Phyllis Hargrave and Linda Albright

Project Staff: John Metesh, Robin McCulloch, Karen Porter, Kenneth Sandau

Funding Sources: U.S. Geological Survey (USGS) and the Montana Bureau of Mines and Geology (MBMG)



Issue

The U.S. Geological Survey wishes to expand its understanding of the geologic context, size, nature, and distribution of mineral deposits in Montana as a part of expanding its understanding of deposits in the United States and worldwide. The Montana Bureau of Mines and Geology can provide its unique expertise and knowledge, particularly about the geology and mineral deposits of Montana.

Objective

The purpose of this geologic research is to update the USGS Mineral Resource Data System (MRDS) data base as a part of a nationwide effort. Only the most significant deposits were targeted for this initial update. Information on the characteristics of a deposit to be updated include (1) location, (2) deposit type, size, and environment, (3) commodities (type, ore and non-ore materials, comments), (4) geology (host rocks, age, alteration, tectonic setting, and geologic structure), (5) workings, (6) exploration/development/ reclamation, and (7) references.

A separate part of this project entails providing digital geologic maps to the USGS for mineral resource, mineral environmental, and ecosystem assessments.

Approach

The MRDS database was imported in a Filemaker Pro format and the most significant deposits, as defined by criteria determined in mutually agreed upon sources, were chosen for the initial updates. “Significant” deposits were classified using minimum production or resource criteria. Most of the mineral production in Montana came from a relatively small number of mines; these were the focus of this project. Information of individual significant deposits was obtained from published and unpublished sources—through library research including professional publications and serials, textbooks, and theses or dissertations. Current information sources such as company annual reports, newspaper clippings, and personal communication were utilized. The information was added to the MRDS database in the predetermined format.

Progress during the 1999–2001 Biennium

Out of a relatively few “significant” deposits in Montana, ten MRDS records of the prioritized significant deposits in Montana were completely updated to the extent of current knowledge available. Other deposits had pertinent information updated to the point that

they were excluded from being considered a “significant deposit.”

A digital geologic map derived from USGS Geologic Investigations Series Map I-2593 (the southwest quarter of the Cut Bank 1° x 2° quadrangle) was delivered to the USGS as a separate part of the project.

Plans for the 2001–2003 Biennium

A modification of the original agreement between the U.S. Geological Survey and the MBMG provides for extension of the original agreement and provides for further updates of additional significant deposits in Montana. This work will proceed toward the goal of a final product that will include a report and a map produced at a later date.

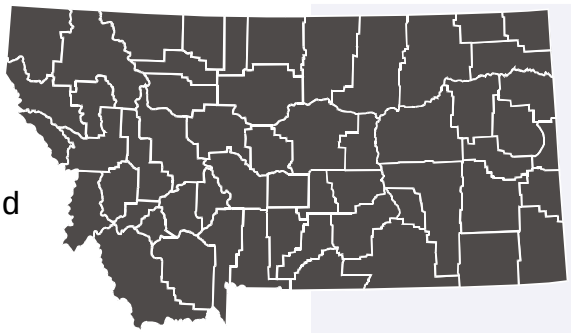
Project Title: Industrial Minerals of Montana

Location: State Wide

Period of Project: Ongoing

Project Leader: Richard B. Berg

Funding Sources: Montana Bureau of Mines and Geology



Objective

To provide information that will aid in the development of Montana's industrial mineral resources and to provide information on industrial minerals to the general public.

Approach

1. Field and laboratory investigation of industrial mineral resources of Montana and the release of this information through publications or open-file reports by the Montana Bureau of Mines and Geology and articles in other publications. Methods range from grass-roots exploration as was accomplished in recent years for chlorite to detailed analyses as involved in investigations of talc and also of sapphires.

2. Provide technical information, primarily through petrographic analysis and mineralogical determinations to prospectors and those involved in the development of industrial mineral deposits.

3. Provide information on markets for specific industrial minerals and also information on recent developments in the industry.

Progress during the 1999–2001 Biennium

A lengthy report on zeolite occurrences in western Montana was formally submitted for publication by the Montana Bureau of Mines and Geology. Investigation into some unusual talc continued. A new investigation bearing on the source of some Montana sapphires was begun.

Plans for the 2001–2003 Biennium

Contingent on receiving funding, begin an investigation of aggregate resources in two western Montana counties with high rate of population growth.

Information Products (Several in cooperation with the U.S. Geological Survey).

Berg, R.B., and Crouse, DL., accepted for publication, The Antler chlorite mine, southwestern Montana, rediscovery, geology, and closure: Proceedings Volume for the 35th Forum on the Geology of Industrial Minerals, Utah Geological Survey.

Berg, R. B., and Cox, B.E., Submitted for publication by the MBMG, Zeolite occurrences in western Montana.

Berg, R.B., and Dahy, J.P., submitted for publication, Montana sapphires: Proceedings Volume for the 36th Forum on the Geology of Industrial Minerals by The Geological Society (U.K).

Berg, R.B., 1999, Montana talc: Gem of the Treasure State: North American Mineral News, No. 53, p. 11–12.

Van Gosen, B.S., Hammarstrom, J.M., Kellogg, K.S., and Berg, R.B., 1998, Map showing areas of garnet resources in bedrock and placer in the Blacktail Mountains, and the Gravelly, Greenhorn, Ruby and Snowcrest Ranges of southwestern Montana: U.S. Geological Survey Open-File Report 98-224-A, scale 1:250,000.

Van Gosen, B.S., Berg, R.B., and Hammarstrom, J.M., 1998, Map showing areas with potential for talc deposits in the Gravelly, Greenhorn, and Ruby Ranges and the Henry's Lake Mountains of southwestern Montana: U.S. Geological Survey Open-File Report 98-224-B, scale 1:250,000.

Users of this Information

1. Companies who are considering development of a Montana deposit or who are looking for a specific industrial mineral.
2. Industrial mineral producers in Montana.
3. Individuals who have a Montana deposit that they are interested in developing.
4. Landowners (private or public) who are interested in the mineral resources on their land.
5. The general public who are just simply curious about some aspect of industrial minerals.

Project Title: Mineral Information and Statistics Program

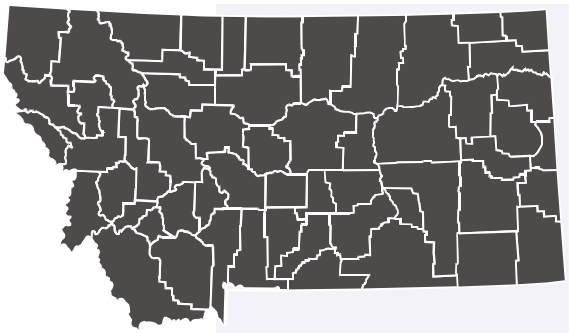
Location: State Wide

Period of Project: Ongoing

Project Leader: Robin McCulloch

Project Staff: One part-time research aide

Funding Sources: Montana Bureau of Mines and Geology



Problem

Mineral information and statistical data are needed by state and federal agencies, industry, industry support companies, and private citizens

Objective

Data are gathered and compiled by the project staff in a number of reports to answer the various questions on the mineral industry.

Approach

Data are secured from companies and individuals where available; mine maps are generated on properties as access is secured; production records on the larger companies are gathered by the US Geological Survey and shared with the Bureau. Production on smaller operations are gathered by the Bureau. Historic and current mineral property files are gathered and maintained in an archive. Staff members publish reports on the industry, present papers and answer specific requests for mineral data. These requests range from the health of the industry to where can I pan for gold.

Progress during the 1999–2001 Biennium

The mine map collection has been inventoried and the mineral property files are about 30% completed. Both are computer retrievable and sortable. Database work continues as the Bureau has shifted to a new batabase system. Extensive data collections were received as donations for Alder Gulch, Silver Star, Bald Butte Molybdenum, Hecla and various and sundry properties across the state. The collections represent millions of dollars of expenditures to gather the data. Over 1500 telephone requests for data were processed and hundreds of email requests. Mineral potential reports for conservation easements were completed for Montana Fish wildlife and Parks as well as for federal agencies and organizations such as the Rocky Mountain Elk Foundation. Although letters and visits are still common, the trend in requesting data is rapidly migrating towards electronic inquiries.

Plans for the 2001–2003 Biennium

The focus of activities will continue to be in gathering and perserving data as they become available. More effort will be put into converting paper files into electronic files in easily retrievable data bases.

Information Products

McCulloch, R., in press, Montana Mining Directory 1995–1998, MBMG Miscellaneous Contributions 18. (Expanded from 1995 to 1996 to save printing costs)

McCulloch, R., 1998, Annual Review 1997, State Activities, Montana: Mining Engineering, May, p. 89–91.

McCulloch, R., 1999, Annual Review 1998, State Activities, Montana: Mining Engineering, May.

McCulloch, R., 2000, Annual Review 1999, State Activities, Montana: Mining Engineering, May.

Project Title: Small Mine Operators Assistance Program

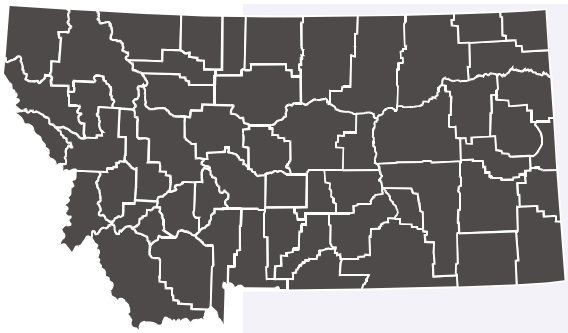
Location: State Wide

Period of Project: Ongoing since the 1950s

Project Leader: Robin McCulloch

Project Staff: Robin McCulloch assisted by Bureau staff as needed

Funding Sources: Bureau of Mines and Geology and private donations



Problem

Small operations lack sufficient cash flow to support technical staff. This often leads to inefficient operation, premature closure, and environmental problems.

Objective

Staff provides technical assistance, contacts, and guidance to ensure the wise use of resources and minimum environmental problems. The economic health of small mining enterprise without damage to the environment is the priority.

Approach

The staff mining engineer regularly visits mining operations across the State. Contacts are typically made as referrals from other miners, state and federal regulatory agencies. Technical services typically include operational instruction, feasibility assistance, geologic mapping, surveying, sampling instruction, mine design, reclamation planning, permitting guidance and contacts to qualified consultants.

Progress during the 1999–2001 Biennium

Properties were visited throughout western Montana. The main focus of the field time was directed to the primary mineral belt north and south of Butte. Research was completed on a new book on placer evaluation. The result will contribute to standardizing the analysis of these deposits. Although development of lode properties has been stagnant during this time of low metal prices, the interest in placer has been steady to increasing. Sampling instruction was provided to over 40 placer enthusiasts near Libby, and design and sampling assistance was provided to 14 small placer operators near Butte and Helena. Mine visits were made to three small lode properties. The U.S. Bureau of Land Management provided funding to send our mining engineer to Alaska to observe how placer operations are conducted in that region.

Plans for the 2001–2003 Biennium

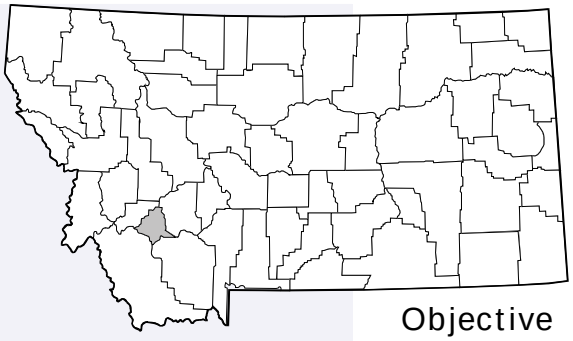
Operations will be continued at historical levels. Activities will continue to get more complicated with more restrictive federal policies.

Information Products

Applied Placer Exploration and Evaluation by Robin McCulloch, Bob Lewis, Don Keill, and Matthew Shumaker.

Consumers

Mine operators, prospectors, hobbyists, state and federal agencies



Project Title: Mineral and Energy Resources
Location: Mineral Museum, Montana Tech
Period of Project: Since 1901
Project Leader: Richard Berg, Ginette Abdo
Funding Sources: Private Donations, Montana Bureau of Mines and Geology

Objective

To provide interesting and informative displays of mineral specimens with particular emphasis on specimens from the Northern Rocky Mountains and to create educational activities that enhance an understanding of the earth sciences and our natural resources.

Approach

1. Displaying varied and aesthetically intriguing, fine mineral specimens.

2. Conducting informative tours, workshops, and community involved geology related activities.

3. Providing information to visitors on subjects ranging from the identification of rocks and minerals to descriptions of the mining history of Butte and locations of tourist points of interest.

Progress during the 1999–2001 Biennium

Group tours are an important activity of the Museum and during the past biennium about 2,000 individuals in over 100 groups were guided through the Mineral Museum. Students are given exercises that require them to find specimens in the Museum and emphasize the uses of minerals. There were an estimated 22,000 visitors, exclusive of those in group tours.

Other museum activities this biennium included the addition of a pictorial exhibit highlighting mining camps in southwestern Montana and several larger size visitor-accessible minerals. An interpretive dimension was added to several of the displays and labels were updated on several hundred specimens. Through the Earthquake Studies Office, an earthquake display entitled “Montana on Shaky Ground” and an interactive computer illustrating earthquake occurrences throughout the world add a new dimension to the Museum. In addition, workshops and lectures have become part of a spring series to encourage community outreach. Some Museum activities included:

Sketching minerals

Rock and mineral identification workshop

Lectures on meteorites and the discovery and unearthing of a 400-pound quartz crystal

On-site school visits show casing rock and minerals

In addition to the 1,300 mineral specimens on display, there are over 15,000 specimens in storage. The collection is now in a computerized data base that facilitates information acquisition.

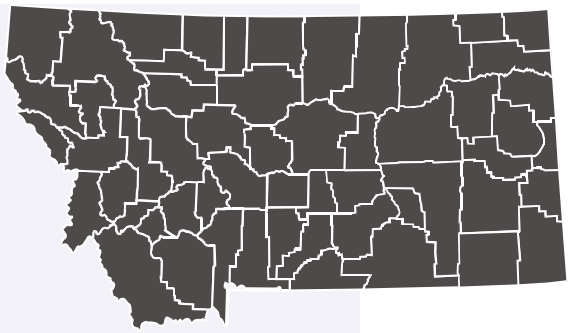
Plans for the 2001–2003 Biennium

The plans for this biennium include continued educational outreach through the schools and the community, and improvement

in the mineral displays. Proposals will be written to help fund Museum improvements.

Information Products

The Mineral Museum does not issue formal publications, but mineral cards containing six specimens of economic minerals of Montana with brief descriptions are presented to young visitors.



Project Title: Montana Seismograph Network and Earthquake Studies Office

Location: Thirty-two seismograph stations collect ground motion data in western Montana. These data are analyzed to report on earthquake occurrence throughout the state.

Project Period: Operation of the Montana seismograph network is an ongoing project initiated in 1980.

Project Leader: Michael Stickney

Project Staff: Part-time student assistants

Funding Sources: MBMG, Confederated Salish and Kootenai Tribes, U.S. Geological Survey, Department of Defense, and National Institute of Safety and Health

Problem

Western Montana has a history of large damaging earthquakes and remains seismically active. Many of these earthquakes (including the magnitude 6.8 quake north of Three Forks in 1925 and the 1935 magnitude 6.3 and 6.0 quakes that badly damaged Helena) occur at depth along faults that do not extend to the Earth's surface. The seismic hazards associated with earthquakes on these "blind" faults cannot be evaluated with traditional geologic studies of faults and are best studied with data from a permanent network of seismograph stations. As the population and infrastructure of quake-prone western Montana continue to grow, so increases the exposure to seismic hazards.

Objective

Monitor, analyze, and report on Montana earthquakes and evaluate seismic hazards. With a better understanding of the earthquake process here in Montana and the faults along which they occur, so increases our ability to protect against the effects of future earthquakes.

Approach

A network consisting of 32 seismic monitoring stations is operated throughout western Montana—the most seismically active region of the state. Signals from 20 remote seismograph stations are transmitted directly to the MBMG using low-power FM radio links while signals from the remaining 11 stations are recorded at two regional centers and then downloaded via telephone modem or the Internet for analysis. Signals from a new digital station are retrieved via satellite link and Internet. The times, location, and magnitudes of earthquakes are determined and cataloged. Significant earthquakes are reported to appropriate state and federal agencies (Montana Disaster and Emergency Services, Montana Dam Safety Program, Confederated Kootenai and Salish Tribes Dam Safety Program, and U.S. Geological Survey), the public, and the media. A listing of recent earthquakes is available via the World Wide Web.

Progress during the 1999–2001 Biennium

1. Data from the Montana seismograph network were used to locate and catalog over 1040 earthquakes with magnitudes ranging

from less than 1.0 to 5.3 in western Montana between January 1999 and March 2000. The largest Montana earthquake in 25 years struck in the Red Rock Valley south of Dillon on 20 August 1999. This magnitude 5.3 earthquake was widely felt in western Montana but caused only minor damage. The MBMG Earthquake Studies Office was the authoritative source of information on the time, location, and size of the earthquake and the numerous aftershocks that followed. The McKenzie Canyon seismograph station (operational since 1989) is sited within five miles of the main shock epicenter and provided excellent focal depth control for this earthquake sequence. In June 1999, a new data acquisition system was installed at the Earthquake Studies Office that seamlessly integrates analog and digital data and exchanges seismic data with surrounding networks and the National Earthquake Information Center in real time.

2. The collaborative effort between MBMG and the Confederated Salish and Kootenai Tribes (CSKT) continues to successfully operate the Flathead seismic network, representing the northwestern segment of the Montana seismograph network. Data from this six-station network vastly improves seismic monitoring coverage in northwest Montana. The CSKT also provides generous support for operation of seismic stations in the Missoula region and analysis of northwest Montana seismicity.

3. Completed the project "Earthquake Mitigation through Public Education and Preparedness" funded through the Hazard Grant Mitigation Program of Montana Disaster and Emergency Services (DES). This multifaceted project educates the public about earthquake hazards and gathers state-of-the-art seismic data for rapidly providing accurate earthquake information. Under this project, MBMG published a new map of western Montana showing active and potentially active faults along with earthquake epicenters. A traveling display was created that illustrates seismic hazards in Montana and a printed pamphlet describes hazard mitigation measures. The DES grant also provided funding for high-quality sensors that were installed at a newly refurbished underground seismic vault 30 miles west of Bozeman. With additional assistance from the USGS this station became operational November 1999 as a cooperating station in the U.S. National Seismic Network. An uninterrupted power supply and emergency generator provide continuous power for network recording and data analysis during power outages at the ESO.

4. With assistance from the National Institute of Safety and Health, we refurbished a telemetry link between Butte and Bozeman and installed two new seismic stations in south-central Montana. This eastward extension of the Montana seismograph network provides expanded coverage of a region that includes the Stillwater Mine. Although underground blasting activity is routinely recorded, no significant seismic events have occurred near the mine since the new stations became operational in October 1998.

5. As part of the rock-burst research project, we successfully recorded a magnitude 3.1 rock burst at the Lucky Friday Mine (near Mullen, ID) with a close array of digital seismographs. Waveform analysis of this event revealed an implosional mechanism. Such a mechanism clearly distinguishes this mining-related seismic event from a natural earthquake of tectonic origin. This type of information is essential for discriminating underground nuclear tests as proposed

by the Comprehensive Test Ban Treaty. A study of rock-burst waveforms recorded at regional distances was not conducted as proposed because seismic recording instruments were not available.

Plans for 2001–2003 Biennium

Continue to study and report on Montana earthquakes using data from the Montana seismograph network. Provide information about earthquakes, fault, and seismic hazards in Montana to appropriate agencies. To better provide this service, we plan to install new computers in Ronan and Missoula that will transmit seismic data to Butte via the Internet in real-time for rapid analysis. Implement a new database to better analyze, manage, and archive seismic data from the newly integrated Montana seismograph network.

Information Products

Bartholomew, M.J., Lewis, S.E., Russell, G.S., Stickney, M.C., Wilde, E.M., and Kish, S.A., 1999, Late Quaternary History of the Beaverhead Canyon, Southwestern Montana in Hughes, S.S., and Thackary, G.D., eds, Guidebook to the Geology of Eastern Idaho: Idaho Museum of Natural History, p. 237–250.

Stickney, M.C., Haller, K.M., and Machette, M.N., 2000, Quaternary faults and seismicity in western Montana: 1:750,000 scale map with text, MBMG Special Publication No. 114.

Full-color pamphlet on earthquake preparedness.

Abstracts

Stickney, M.C., and Lageson, D.R., 1999, The Nov. 6, 1997 M 3.7 Belgrade, MT earthquake: Unusual aspects and their implications to regional seismicity: Geological Society of America Abstracts with Programs, vol. 31, no. 4, p. A-57.

Stickney, M.C., 1999, Characteristics of Recent Seismicity in Southwest Montana and its Relation to Late Quaternary Faults: Seismological Research Letters, v. 70, p. 237.

Stickney, M.C., and Lageson, D.R., 1999, Recent earthquakes in southwest Montana: Characteristics of low to moderate magnitude seismicity in an extensional regime: Association of Engineering Geologists, Program with Abstracts, 42nd Annual Meeting, p. 86.

Stickney, M.C. and Lageson, D., 1999, The 1999 Red Rock Valley, Montana earthquake; Slip in the footwall of a major range-bounding normal fault: EOS Transactions, American Geophysical Union 1999 fall meeting program and abstracts, p. F725.

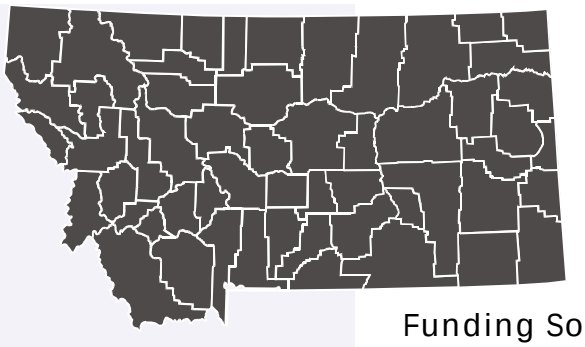
Rohay, A.C., Sprenke, K.F., and M.C. Stickney, 1999, Source characterization of a large rockburst, Coeur d'Alene Mining District: in Proceedings of the 21st Annual Seismic Research Symposium on Monitoring a Comprehensive Test Ban Treaty, Defense Special Weapons, Nuclear and Chemical and Biological Defense Programs, 4 p.

Rohay, A.C., Sprenke, K.F., and M.C. Stickney, 1999, Moment tensor of an implosional rock burst, Coeur d'Alene Mining District, Idaho: Fall Meeting of the American Geophysical Union, San Francisco.

Stickney, M.C., and Lageson, D.R., 1999, The 1999 Red Rock Valley, Montana earthquake: Seismological constraints and structural model: EOS, Transactions, American Geophysical Union, vol. 80, no. 46, p. F725.

Stickney, M.C., 2000, What's shakin' in Montana? Past earthquakes and future hazards: Geological Society of America Abstracts with Programs (Rocky Mountain Section, Missoula).

Ruleman, C., Lageson, D.R., and Stickney, M.C., 2000, Paradise Valley seismic gap, southwest Montana: Geological Society of America Abstracts with Programs (Rocky Mountain Section, Missoula).



Project Title: National Coal Resources Data System

Location: State Wide

Period Of Project: Ongoing since 1982

January 1999–December 2001

Project Leader: Edith M. Wilde

Project Staff: Wayne Van Voast, GIS specialist, one student assistant

Funding Sources: U.S. Geological Survey, Energy Team, Montana Bureau of Mines and Geology

Issue

The U.S. Geological Survey (USGS) established the National Coal Resources Data System (NCRDS) as part of their National Coal Resource Assessment Program. Bureau participation in this project is in its 18th year. The Bureau has considerable information available on all aspects of coal in Montana. Much of these data have been prepared and entered into the NCRDS computer data base, but some remain to be entered. Quality control and verification methods were only recently established for this data base; few of the data have been validated.

Objectives

This cooperative agreement provides funds to the Bureau for preparation of a comprehensive database containing information on Montana's coal reserves. NCRDS personnel are charged with using information provided by all participating states to determine the quality and quantity of all U.S. coal reserves. Reserve assessments are then used to provide consistent data to policy makers in Washington and as a research tool.

Therefore, the main goal of this project is to validate and correct data from Montana that is currently in the National database, so that NCRDS and the Bureau can provide this data to the public in a timely and efficient manner.

Approach

NCRDS currently uses a UNIX-based operating system. They have modified public-domain programs and created other programs to meet the specific needs of NCRDS. The resulting program suite is user friendly, but functions slowly on the Internet. Therefore, correction and addition of data are slow.

Any additional data available are prepared, entered, and verified. The validation process is time consuming and is proceeding first in areas needed for other projects. All data are checked against in-house records, necessary corrections are made, and missing information is added. Efforts are also being made to add outcrop, production, and chemical data to this data base.

Progress during the 1999–2001 Biennium

At the end of 1999, the Montana Portion of the data base contained information for 7,638 data points (locations) from coal fields across the state. Locations for all data are being digitized and added to the data base after the initial entry of data. Data from over 1000 new locations contributed by Western Energy Company have

also been prepared and entered.

At the end of 1999, outcrop locations for all coal beds in three 1:24,000 map sheets from the economically important Powder River Basin area of Montana have been digitized and added.

The validation process has been totally completed for 24 of the 1:24,000-scale map sheet areas in the Powder River Basin; validation is continuing, prioritized by needs of other projects.

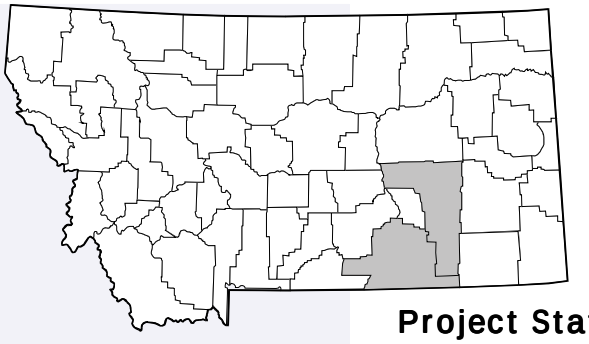
A data base for chemical data was created in Microsoft Access format. All publicly available data from USGS for Montana have been entered. Additional data are being entered as time permits. Additionally, production statistics have been entered into Microsoft Excel spreadsheets.

Plans for the 2001–2003 Biennium

Continue preparation and entry of any additional data not currently in the database. Continue entry of chemical and production data as time permits. Outcrops from six more quadrangles are expected to be added by the end of 2000. Continuation of the validation process; at least 21 additional quadrangles are expected to be completed by the end of 2000. Efforts are being made to internalize this data base.

Information Products

Currently, an informal report is submitted to NCRDS at the end of each year. Additionally, a presentation is given before the NCRDS Coordination and Planning Committee at its annual meeting. Data in this data base are available to the public as either paper copy or in limited digital formats.



Project Title: Coal Availability Program

Location: Southeastern Montana, Powder River Basin

Period Of Project: Ongoing since 1995, renewed yearly; current contract periods: April 1999–March 2000 and April 2000–March 2001

Project Leader: Edith M. Wilde

Project Staff: Wayne Van Voast, GIS Specialist, two student assistants

Funding Sources: U.S. Geological Survey, Energy Team, Montana Bureau of Mines and Geology

Issue

Original reserve estimates for the nation were made over 20 years ago and in many cases were based on few data locations with only tentative coal-bed correlations. These estimates included all resources at least 30 inches thick and under less than 1000 feet of overburden. They did not consider any restrictions placed on coal mining, likely mining methods, nor essential economic factors. Based on these estimates, the nation was believed to have thousands of years of reserves.

Differences between these estimates of total reserves and the amount of coal, which could actually be mined, were highlighted by Coal Availability studies begun in the Eastern Coal Province in 1986. Therefore, study of this issue was extended into the remaining coal provinces and began in Montana in 1995.

Objectives

To measure the magnitude of restrictions placed on coal mining and determine how these restrictions will affect mining in the economically important Powder River Basin area of Montana.

Results will be usable by state and federal agencies to update estimates of the National and State reserves so that a more realistic picture of our energy future can be made.

Approach

Information contained in the National Coal Resources Data System (NCRDS) data base with the addition of other available data is being used to produce estimates of the basic coal reserves at the 1:24,000 scale in five separate study areas in the Powder River Basin area of Montana. Study locations were chosen so that the major coal producing zones could be represented, so that differences in the conditions affecting mining in the immediately surrounding area could be represented.

The methodology, developed specifically for this program by the USGS, is unique because it applies restrictions to the coal reserve before the amount of resource is estimated. Considered restrictions are placed in two basic categories: technologic and land use. The technologic restrictions consist of physical factors: coal too thin to surface mine, overburden too thick to remove, and beds too close together. The land-use restrictions are covered in state and federal regulations: locations of national parks, public use areas, buildings, towns, utility lines, cemeteries, etc.

For each study area, the specific restrictions are determined, the area covered by each restriction is determined, and the amount of coal restricted is calculated. The available coal is then determined by removing restricted areas from the reserve area, and the tonnage available is calculated.

Progress during the 1999–2001 Biennium

The first study area (Willow Crossing 7.5-minute quadrangle) is complete, and two publications resulting from the study are now in the publications division. The results there indicate that the original estimates of coal reserves in the area were low by about 10 percent. However, only 44 percent of the original coal resource could currently be mined due to land-use and technologic restrictions. Land-use conflicts and multiple use issues cause the greatest impact in this area. The two largest restrictions are the location of Custer National Forest lands and the location of alluvial valley floors.

The second study area (Colstrip East and Colstrip SW 7.5-minute quadrangles) is also complete. The results are currently undergoing review before publication. In this area, prior mining has the greatest impact, but about 70 percent of the original resource could be mined.

The third (Otter and Reanus Cone 7.5-minute quadrangles) study area and the fourth (Half Moon Hill and Taintor Desert 7.5-minute quadrangles) study areas are nearing completion. Field and bed correlation work is complete. Restrictions and mined-out areas have been determined. GIS work and report writing is underway.

Field work and initial bed correlations for the fifth study area (Forks Ranch and Lacey Gulch 7.5-minute quadrangles) are complete, as well.

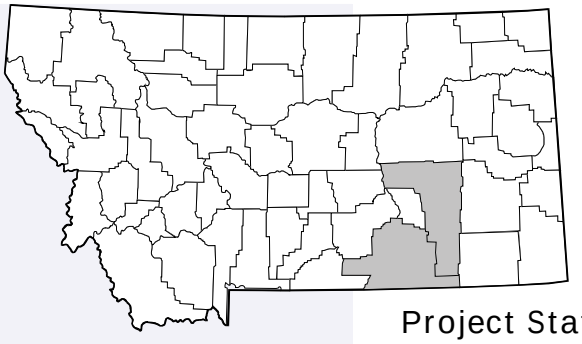
Plans for the 2001–2003 Biennium

Complete all remaining work for the third, fourth and fifth study areas. Write required reports and send through the review and publication process.

Information Products

Cooperative agreements require publication of the results of each study area. MBMG Report of Investigation #6 and Open File Report 367 will cover the first study area. Each area is being prepared for publication as it is completed.

Yearly progress reports are presented at the annual meeting of the Coordination and Planning committee for the Coal Availability program.



Project Title: National Coal Resource Assessment Program

Location: National Southeastern and Eastern Montana, Powder River and Williston Basins

Period Of Project: Five years beginning 1996

Project Leader: Edith M. Wilde, as representative for Montana beginning 1997

Project Staff: Romeo Flores, USGS, Denver, Program Director; Stephen Roberts, USGS, Denver, Regional Director; and one MBMG student assistant

Funding Source: U.S. Geological Survey, Energy Team

Issue

Recently enacted federal mining regulations, as well as new air and water quality standards, have brought into question the accuracy of reserve estimates currently being used for energy policy decisions. Current reserve estimates are based on data over twenty years old and considerable coal has been mined during that time. Additionally, results of recent Coal Availability Studies have emphasized the need for updated reserve estimates based on conditions that are more current.

Objectives

To re-evaluate the Nation's coal reserves using a basin by basin approach, and emphasizing coal beds/zones currently being mined or likely to be mined in the next 20 years.

Approach

USGS personnel are compiling all available information into data bases for each basin under study. The STRATIFACTS software program is being used for data storage and initial bed correlations. MBMG is assisting with data acquisition, determination of significant beds, coal bed correlation, data interpretation, and organization of field trips. Data from recent studies in Montana is being included.

Data will then be combined into a National data base, and used to update the National reserve estimates. Derivative products, charts, maps and tables will be prepared based on the updated information obtained by this program. Data will be made available to policy makers in Washington once the study is completed.

Progress during the 1999–2001 Biennium

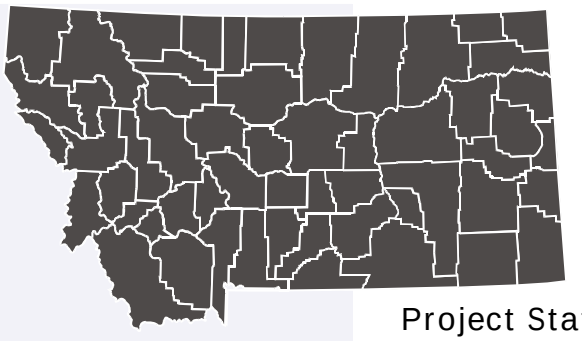
Currently available data for both the Williston and the Powder River Basin areas of Montana has been submitted to the program. Determination of regional reserve areas has been completed. To date, the results have been published as USGS Open File Report 99-376 (1 CD ROM disc) and USGS Professional Paper 1625-A (two CD-ROM discs). Three additional publications are undergoing review.

Plans for the 2001–2003 Biennium

Assist with the completion of any pending publications. All major work and publications are expected to be complete by the end of 2001.

Information Products

Regional information has been published in CD ROM form for the Williston and the Powder River Basins. A finalized version including the basin-wide results for the entire nation is expected to be published by the end of 2001.



Project Title: National Coal Quality Inventory Program

Location: National, State of Montana

Period of Project: Began officially in late 1998, unknown length, depends on EPRI funding

Project Leader: Edith M. Wilde, as representative for Montana and the Northern Great Plains Region

Project Staff: Robert Finkelman and John Repetsky of the USGS, coal geologists from participating states

Funding Source: Electrical Power Research Institute through the U.S. Geological Survey

Issue

Nearly 60 percent of the power generated in the United States comes from the combustion of coal. Recently enacted federal mining regulations, as well as new air- and water-quality standards imposed by the EPA (Environmental Protection Agency), have increasingly focused on coal quality issues. Most publicly available data are more than 20 years old and focus on in-ground conditions.

Objectives

To collect recent coal samples that reflect the character of the coal currently being sold and used. To create a data base of coal-quality information containing reliable, accurate, comprehensive and accessible information. Maintenance of the existing data base, promotion of it existence, dissemination of information and expansion of the data base are secondary goals.

Approach

Discussions and planning sessions for this program have been underway for nearly four years. The mining companies in each state will be consulted and cooperative agreements established. In addition to in-ground sampling NaCQI, places emphasis on gathering run-of-mine and power plant samples. Data from proximate, ultimate, and trace element analysis will be included. By sampling from a variety of locations and facilities, a broader understanding of the quality of produced coals throughout the nation can be achieved. Emphasis is also being placed on sampling beds that are currently being mined and those expected to be mined within the next 20 years.

Progress during the 1999–2001 Biennium

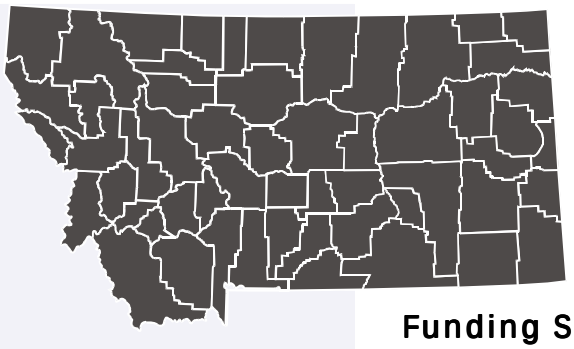
During the first national semi-annual meeting in 1999, the level of funding was discussed and decisions were made on the allocation of available funds. One eastern state (West Virginia) and one western state (Wyoming) were funded. At the second semi-annual meeting, more funding had been attained. A second eastern state (Kentucky) and a second western state (Colorado) were chosen for funding, and asked to submit work proposal. At the first semi-annual meeting in 2000, the proposals from the two sates were approved. Allocation of funds available at that time was discussed. A request for pre-proposals has been issued.

Plans for the 2001–2003 Biennium

MBMG will prepare and submit one or two proposals for this program and begin work if funded.

Information Products

The results of the analysis obtained through this program will be entered into a national database that will ultimately be publicly available. Additional computer generated products are anticipated.



Project Title: Compilation and Publication of a Landslide Location Map and Index

Location: State of Montana

Period Of Project: Unknown

Project Leader: Edith M. Wilde

Project Staff: Pat Kennelly, GIS Specialist; David Lopez, Geologist

Funding Sources: Montana Department of Transportation, Montana Bureau of Mines and Geology

Issue

Many areas of Montana are prone to earth movement. Where these events occur in proximity to human-made structures, remediation can be expensive. Anything affecting slope stability, including seismic activity and construction, can activate sliding. MBMG has locations of landslides plotted at various scales, and an incomplete database index of related information and locations.

Objectives

Many areas of Montana are undergoing rapid development and growth, and information is needed on hazards facing developers. The main goal of the program is to make the data useful to the public. Through compiling the locations and shapes of the sites of known earth-movement onto one map, completing and updating the index database, this goal can be achieved. An additional goal is recognition of high-risk areas where earth movement is currently active or has been in the past.

Approach

Compilation all previously published data, other sources of known locations, and data available from current mapping projects onto one map. Creation of a usable database structure for cataloging and entry of each location. Development of a working system of identification of types and causes of movement. Application the system to the known data and entry of this information into the index. Entry of any other pertinent information into the database. Identification of formations or lithologies prone to earth movements.

Progress during the 1999–2001 Biennium

A pre-proposal was submitted at the end of 1998. The pre-proposal was accepted for development into a full proposal at the end of 1999. An initial meeting held in early 2000 outlined needs and desires of the funding agency. A draft proposal was completed and presented to the Technical Panel from the Montana Department of Transportation for this project at the end of March 2000. A final proposal will then be completed and submitted.

Plans for the 2001–2003 Biennium

If the work proposal is accepted for funding, complete as much work as possible on this project.

Information Products

A publicly available data base will be created. Maps showing locations types of earth movements will be completed and digitized. Reports will be completed as required for the project.

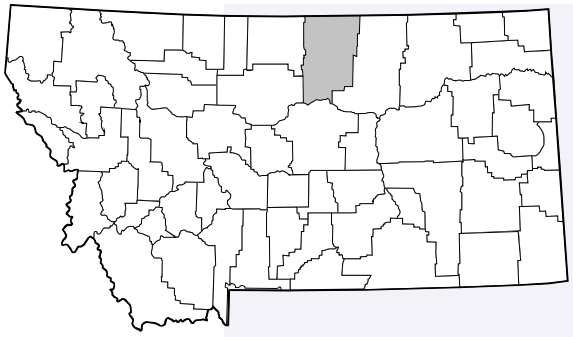
Project Title: Petroleum Reservoir Characterization Program

Location: NE Rabbit Hills Oil Field, Blaine County, northeast of Chinook, Montana

Period of Project: Six years, ending October 1999

Project Leader: Charles Wideman (Montana Tech)

Project Staff: Karen Porter; Curtis Link and Tarek Ahmed (Montana Tech); Ray Ford and Marc Hendrix (The University of Montana)



Funding Sources: U.S. Department of Energy EPSCoR Program, Montana University System, and the Montana Bureau of Mines and Geology

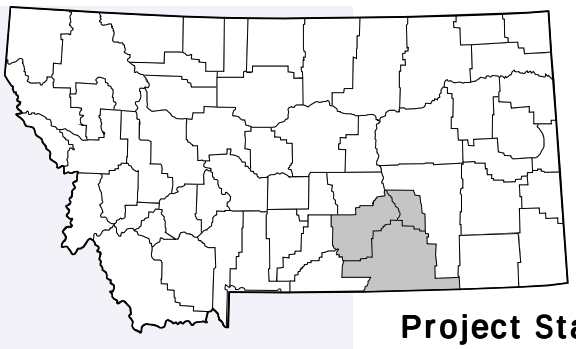
Summary

This program, now completed, was focused on development of integrated expertise at the three main campuses of the Montana University System and the Montana Bureau of Mines and Geology in the characterization of petroleum reservoirs of the state. The participants were from the disciplines of Geology, Geophysics, Petroleum Engineering, Mathematics, and Computer Visualization, including teaching and research faculty and undergraduate and graduate students on the three campuses. The objectives of the collective research were to (1) develop new methods for integration of research results, (2) develop a cross-trained reservoir characterization research team, and (3) conduct technology transfer within the academic, governmental, and petroleum industry sectors of Montana.

Outcomes over the six-year duration of this program included numerous technical presentations, at least five master's theses, several workshops for members of the petroleum industry, dramatically upgraded computational hardware and software on two of the campuses, and a research capability for addressing specific questions about Montana's petroleum reservoirs. Of primary, ongoing interest is the program's web site: **http://www.cs.umt.edu/DOE/**. The materials and data available on this site have been used by faculty at several universities from Montana to Texas to Australia.

Information Products during the 1999–2001 Biennium

Porter, K.W., Wideman, C.W., and Conaway, J.M. 1998, Geology of the Jurassic Sawtooth reservoir at NE Rabbit Hills field, north-central Montana, *in* Christopher, C.E., Gilboy, C.F., Paterson, D.F., and Bend, S.L., eds., Eighth International Williston Basin Symposium: Saskatchewan Geological Society Special Publication Number 13, p. 109–114.



Project Title: Valley-Fill Sandstones in the Kootenai Formation on the Crow Indian Reservation, South-Central Montana

Location: Crow Reservation; Yellowstone, Big Horn, and Treasure Counties

Period of Project: July 1996–July 2000

Project Leader: David Lopez

Project Staff: Susan Vuke, GIS staff, student research assistants

Funding Source: U.S. Department of Energy

Problem or Issue

The Crow Reservation is in the northern Powder River Basin, a prolific producer of oil and gas. The Reservation, however, has only limited established oil and gas production. This limited production is viewed as being mainly due to the fact that the Reservation is under-explored.

Objective

The stimulation of oil and gas exploration is the main objective of this project. Other objectives include the training of tribal members in concepts of petroleum exploration, including economic and risk factors. By providing summer employment to Crow students interested in geoscience, it is hoped that they will be encouraged to pursue college preparation for a geoscience career.

Approach

Modern geologic and stratigraphic models and detailed surface and subsurface geologic evaluation will be applied to the study of a known oil and gas productive stratigraphic horizon. The result of this careful research should lead to the identification of oil and gas exploration leads in the Crow Reservation area.

Progress during the 1999–2001 Biennium

Field investigations were completed and subsurface data collection have been completed this biennium. Construction of an oil and gas data base for the Crow Reservation area using ARCVIEW has been completed. Subsurface stratigraphic and structural maps of the area have been completed. In addition, geologic maps of the Crow Reservation have been completed and are projected for formal publication in early 2000. Exploration leads using all the data generated have been identified. Soil gas geochemical sampling was used to test these leads for indications of buried hydrocarbon accumulations. One lead has a significant anomaly that can not be explained by surface conditions. Another lead shows a subtle anomaly. The final report is being written and will be released in the summer of 2000.

Information Products

Geologic maps of the Billings, Bridger, Hardin, and Lodge Grass 1:100,000-scale maps will be formally published in the Bureau Geologic Map Series.

The results and recommendations from the oil and the stratigraphic study and the application to oil and gas exploration will be published in the Bureau Reports of Investigation Series. This publication will include stratigraphic and structural maps pertaining to the fluvial channel sandstones in the area.

Project Title: Valley-Fill Sandstones in the Kootenai Formation on the Northern Cheyenne Reservation, South-Central Montana

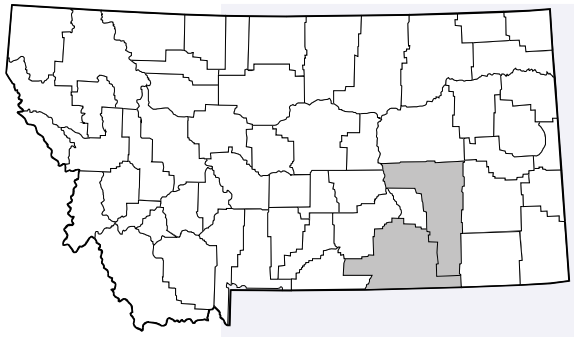
Location: Northern Cheyenne Reservation; Big Horn, and Rosebud Counties

Period of Project: February 1998–July 2000

Project Leader: David Lopez

Project Staff: GIS staff, student research assistants

Funding Source: U.S. Department of Energy



Problem

The Northern Cheyenne Reservation is in the northern Powder River Basin, a prolific producer of oil and gas. The Reservation, however, has no established oil and gas production, which is mainly due to the fact that the Reservation is underexplored.

Objectives

The stimulation of oil and gas exploration is the main objective of this project. Another objective is the training of tribal members by providing summer employment to Northern Cheyenne students interested in geoscience, it is hoped that they will be encouraged to pursue college preparation for a geoscience career.

Approach

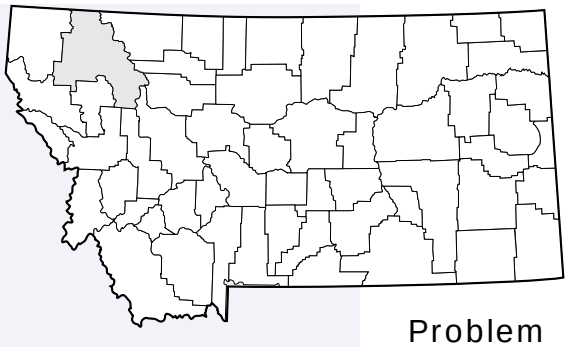
Modern geologic and stratigraphic models and detailed surface and subsurface geologic evaluation will be applied to the study of a known oil and gas productive stratigraphic horizon. The result of this careful research should lead to the identification of oil and gas exploration leads on the Northern Cheyenne Reservation.

Progress During the 1999–2001 Biennium

Field investigations were completed and subsurface data collection have been completed this biennium. Construction of an oil and gas data base for the Crow Reservation area using ARCVIEW has been completed. Subsurface stratigraphic and structural maps of the area have been completed. Exploration leads using all the data generated have been identified. The final report is being written and will be released in the summer of 2000.

Information Products

The results and recommendations from the oil and the stratigraphic study and the application to oil and gas exploration will be published in the Bureau Reports of Investigation Series. This publication will include stratigraphic and structural maps pertaining to the fluvial channel sandstones in the area.



Project Title: Columbia Mountain Landslide
Location: Flathead County
Period of Project: 1998–2000
Project Leader: Larry Smith
Funding Source: Montana Bureau of Mines and Geology

Problem

A large landslide in the Flathead River valley was recognized during surficial geologic mapping of the valley. The landslide is about three miles southeast of the city of Columbia Falls, near the base of the northern Swan Range. Because some features associated with the hill slope failure suggested that a future failure could take place and that the area is undergoing residential development it was decided to do a preliminary evaluation of the area.

Objectives

The volume of the landslide and the timing and mechanism of movement were previously unknown. This project focused on determining the extent and thickness of the deposit, inferring the timing of movement, and assessing the significance of extension cracking in bedrock in the northern Swan Range.

Approach

Mapping of the surficial extent of landslide deposits was done with aerial photographs and field mapping. Logs of water wells in the area were used to estimate the thickness of the deposits. The timing of failure was inferred by field relations. Mapping of the locations and orientations of tensile cracks in bedrock above the landslide helped to determine the approximate boundaries of a slow-moving bedrock mass near the crest of the Swan Range.

Progress during the 1999–2001 Biennium

The project determined that catastrophic failure at the location of the Columbia Mountain landslide occurred around areas that were occupied by glacial ice sometime between 12,000 and 15,000 years ago. Significant failure has not occurred in the last 12,000 years. Delineation of an extending bedrock mass above the origin of the previous failure suggests that boulder-sized material is actively being produced near the mountain top. It is possible that this material is periodically transported down small drainages to the floor of the valley. There a small risk for a significant failure that could possibly be triggered by an earthquake.

Plans for the 2001–2003 Biennium

none

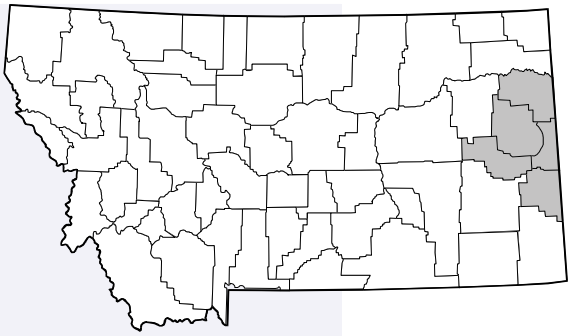
Information Products

Esper, M., 1999, Geologist predicts huge slide: Daily Inter Lake cover story, Sunday October 17, 1999 (information for the story was taken from the following products).

Smith, L.N., 1999, Columbia Mountain Slide—Latest Pleistocene and Future Failure(?), Flathead County, Montana: Montana Bureau of Mines and Geology Geoshorts slide show: http://mbmgsun.mtech.edu/geoshort.htm

Smith, L.N., 1999, Landsliding during latest Pleistocene deglaciation of the Kalispell valley, northwestern Montana, USA: Canadian Quaternary Association-Canadian Geomorphology Research Group 1999 Program and Abstracts, p. 71–72.

Smith, L.N., in review, Columbia Mountain landslide: late-glacial emplacement and indications of continued movement, northwestern Montana, U.S.A: Geomorphology (manuscript submitted October 2000), 22 p.



Ground-Water Occurrence and Availability

Project Title: Hydrogeologic Investigation of the Clark Canyon Landslide, Southwest Montana

Location: Beaverhead County

Period of Project: May 2000–November 2001

Project Leader: Katie McDonald

Funding Sources: Montana Department of Transportation, Union Pacific Railroad, Port of Montana, Butte-Silver Bow County, Montana Bureau of Mines and Geology

Problem

The Clark Canyon landslide, located south of Dillon, Montana, is an ancient landslide that began experiencing renewed ground movement in 1995. The movement is affecting the Union Pacific Railroad (UPRR), an unpaved frontage road along the toe of the landslide, and nearby underground utilities. Efforts by UPRR to stablilize ground movement within the landslide have been unsuccessful and UPRR has considered abandoning the line because of high maintenance costs. In light of the obvious economic consequences to the state of Montana if the line is abandoned, state and local agencies met with UPRR in 1998 and agreed to seek funding for an investigation of the landslide to determine more effective options for stabilizing the slope.

The UPRR tracks were rerouted in 1961 during construction of Clark Canyon Reservoir and Interstate 90. The photo on the left (p. 37) shows the Clark Canyon landslide, the Beaverhead River and the railroad tracks before the tracks were relocated. The photo on the right (p. 37) shows the new railroad bed during construction along the base of the landslide. (Photos courtesy of the U.S. Bureau of Reclamation.)

Objective

The objective of the investigation will be to determine what geologic and hydrologic factors are affecting ground movement within the landslide and what remediation measures can be implemented to prevent future stability problems. The investigation will be conducted jointly by the Montana Bureau of Mines and Geology and a private geotechnical consulting firm on contract with UPRR.

Approach

The investigation will include detailed geologic and hydrogeologic mapping in the vicinity of the landslide, drilling soil borings within the landslide to characterize subsurface conditions, installing instruments to monitor ground-water fluctuations and potential slope movement on a monthly basis, and evaluating the results to determine what options are available to stabilize areas of the landslide prone to ground movement.

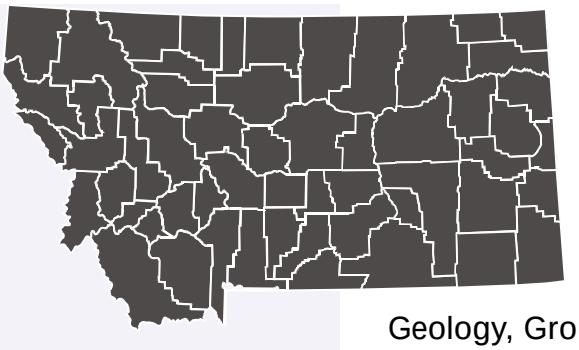
Progress during the 1999–2001 Biennium

MBMG completed geologic mapping in the area surrounding the landslide and used existing and newly acquired data to develop

preliminary hydrogeologic maps and geologic cross sections. MBMG will assist with the subsurface investigation which is scheduled to begin in November 2000.

Plans for 2001–2003 Biennium

Continue to collect monthly data on ground water levels and slope movement until August 2000. MBMG will prepare a project report for MDT by November 2001. A separate report will be prepared by UPRR's consulting firm outlining potential remediation options and associated costs.



Project Title: Montana Ground-Water Information Center

Location: State Wide

Period of Project: Ongoing

Project Leader: Tom Patton

Project Staff: Luke Buckley, student assistants

Funding Sources: Montana Bureau of Mines and Geology, Ground-Water Assessment Program

Issue

Ground-water information generated by projects, water-well drilling, water-quality sampling, and other activities must be accurately stored in an easily accessible place. There is increasing demand for ground-water data by government agencies, private industry, and the public. Each constituency requires that the data be easily obtainable; much publicly funded information is stored in thousands of reports in agency and other libraries and is virtually inaccessible.

Objective

In the most efficient way possible, make ground-water data available to those who need it. Store and maintain information in the data bases for use by the citizens of Montana about well construction, water levels, water chemistry, and materials encountered while drilling.

Approach

Information about ground-water resources derived from drillers' logs, published reports, field measurements, laboratory analyses, and other sources are placed in computer storage for retrieval by interested citizens, government agencies, and private industry. In June 2000, the data bases contained information on more than 165,000 wells, 14,700 water-quality analyses from ground-water sources, 367,000 water-level measurements at more than 5500 locations, and records of materials encountered during drilling at more than 88,000 wells. The MBMG also offers interpretative services to people needing well depth, yield, and water-quality information at potential well locations. Information from the data bases is available in various formats, ranging from photocopies of water well logs to retrievals of thousands of well records shipped via the Internet.

Progress during the 1999–2001 Biennium

More than 16,400 new water-well and monitoring-well records were added to the data bases. Major projects included addition of lithologic records for Deer Lodge, Granite, Lewis and Clark, Powell and Silver Bow counties. The GWIC web site went online in January 1999 and since then, the number of queries serviced has increased on average about 13% each month. During the April–May 2000, the web site was answering about 4500 queries per month. About 1300 registered users have logged onto the data base almost 15,000 times. Initial products of the Ground-Water Characterization Program were added as downloadable maps to the GWIC web site.

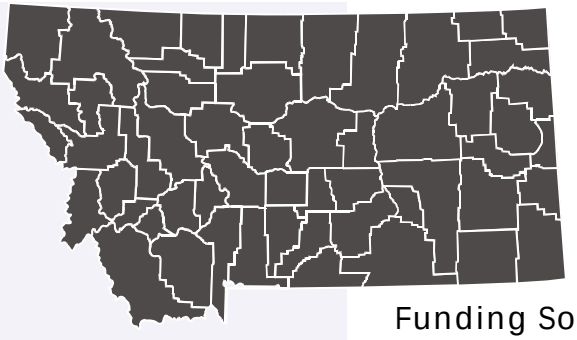
Plans for the 2001–2003 Biennium

The Bureau will continue to add new well-log, water-quality, water-level, Characterization Program products, and other related

ground-water information to the Gwic databases. The web site will continue to be enhanced to make available reports and data.

Information Products

The Ground-Water Information Center can be reached through the internet at **http://mbmggwic.mtech.edu**, by mail at the Montana Bureau of Mines and Geology, 1300 West Park Street, Butte, Montana 59701-8997; by calling 406-496-4336; or by email at gwic@mtech.edu.



Project Title: Montana Ground-Water Monitoring Network

Location: State Wide

Period of Project: Ongoing

Project Leader: Tom Patton

Project Staff: Joe Lalley, Don Mason, Mike Richter, and Leonard Rinehart

Funding Sources: Montana Bureau of Mines and Geology, Ground-Water Assessment Program

Issue

Much like streamflow and precipitation data, ground-water information must be collected over long periods of time to be useful. Long-term data allow managers and others to determine normal water levels in wells, changes in water levels related to climatic conditions, responses of water levels to development in aquifers, and water-quality changes.

Objective

Create a network of water wells from which water-level and water-quality data can be collected and that will provide information on most areas and aquifers in Montana.

Approach

Strategically located water wells are visited and if suitable, added to a network of wells that are periodically measured for water levels and sampled for water quality. The planned number of wells in the network is between 850 and 950. At the end of fiscal year 2000, there were 727 wells in the network and 77 operating water-level recorders. Water-level data gained from the network are placed in the Ground-Water Information Center data base shortly after measurements are made and are easily retrievable by the citizens of Montana.

Progress during the 1999–2001 Biennium

Quarterly water-level data for existing network wells were obtained for fiscal years 1999 and 2000. Water-quality sampling did not occur in fiscal year 1999 because funding shortfalls but about 100 samples were collected late in fiscal year 2000. Field work began in spring 2000 to complete the monitoring network in the northeast and southeast corners of Montana.

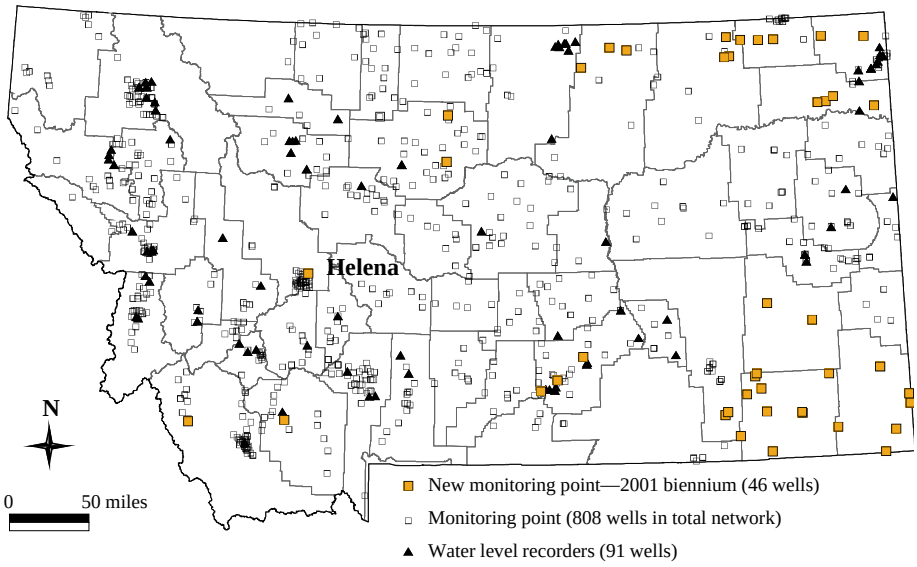
Plans for the 2001–2003 Biennium

Wells within the monitoring network will be measured quarterly and water-level recorders will be serviced. Between 70 and 100 water-quality samples will be collected. About 75 percent of the samples will be from wells not previously sampled and 25 percent will be from previously sampled wells to continue building water-quality trend data. Monitoring points will be established in northeast and southeast Montana to complete the network. Data collected will be placed in the Ground-Water Information Center data bases and be retrievable through the GWIC web site.

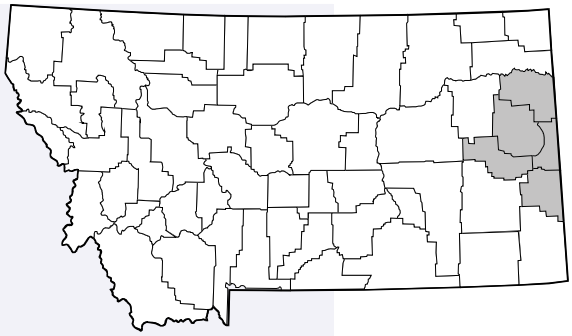
Information Products

Data collected from the monitoring network can be retrieved from the Ground-Water Information Center (GWIC) data bases at

http://mbmggwic.mtech.edu, sending an email note to **gwic@mtech.edu**, or contacting the Information Center by telephone at 406/496-4336.



Quarterly water-level data from about 810 wells help people understand how the ground-water resource responds to climatic and other factors. Additionally, there are about 90 water-level recorders (triangles) in the network that provide continuous to hourly data from selected wells. Water-level data collected from the network are available from the Ground-Water Information Center data bases.



Project Title: Lower Yellowstone River Area Ground-Water Characterization Study

Location: Dawson, Fallon, Prairie, Richland, and Wibaux Counties

Period of Project: July 1993–December 1998

Project Leader: Tom Patton

Project Staff: John LaFave, Larry Smith, Camela Carstarphen, Don Mason, James Rose

Funding Sources: Montana Bureau of Mines and Geology, Ground-Water Assessment Program

Issue

Insufficient information is hampering efforts to properly manage, protect, and develop ground-water resources.

Objective

Provide information to landowners and decision makers about management, protection, and development of ground-water resources by systematically assessing and documenting the hydrogeology and quality of individual aquifers.

Approach

Compile information on the geology and ground-water resources, map aquifer distributions, visit selected wells to measure water levels and basic water-quality parameters, conduct additional testing to determine aquifer properties, and collect and analyze ground-water samples to evaluate water quality and to better understand ground-water flow systems.

Progress during the 1999–2001 Biennium

Open file maps were added as downloadable objects from the Ground-Water Information Center web site. The manuscript for Ground-Water Assessment Atlas No. 1 was completed, reviewed, published, and released.

Plans for the 2001–2003 Biennium

The Lower Yellowstone River Area Ground-Water Characterization Study was completed with the release of parts A and B of Montana Ground-Water Assessment Atlas No. 1.

Information Products

Smith, L.N., LaFave, J.I., Patton, T.W., Rose, J.C., and McKenna, D.P., 2000. Ground-water resources of the Lower Yellowstone River Area: Dawson, Fallon, Prairie, Richland, and Wibaux counties, Montana, Part A–Descriptive overview and basic data.

Ground-water resources of the Lower Yellowstone River Area: Dawson, Fallon, Prairie, Richland, and Wibaux counties, Montana, Part B–10 maps describing the hydrogeology of the Lower Yellowstone River Area.

Project Title: Flathead Lake Area Ground-Water Characterization Study

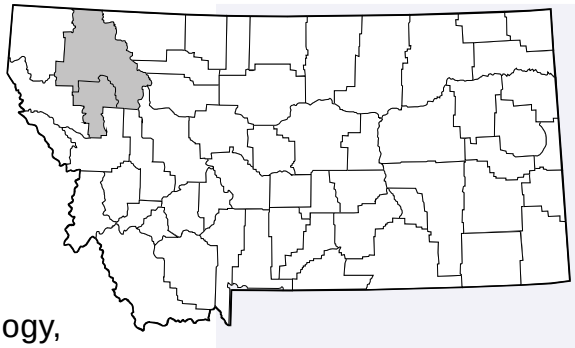
Location: Flathead and Lake Counties

Period of Project: July 1994–December 1998

Project Leader: Tom Patton

Project Staff: John LaFave, Larry Smith, Camela Carstarphen, Don Mason, James Rose

Funding Sources: Montana Bureau of Mines and Geology, Ground-Water Assessment Program



Issue

Insufficient information is hampering efforts to properly manage, protect, and develop ground-water resources.

Objective

Provide information to landowners and decision makers about the management, protection, and development of ground-water resources by systematically assessing and documenting the hydrogeology and quality of individual aquifers.

Approach

Compile information on the geology and ground-water resources, map aquifer distributions, visit selected wells to measure water levels and basic water-quality parameters, conduct additional testing to determine aquifer properties, and collect and analyze ground-water samples to evaluate water quality and better understand ground-water flow systems.

Progress during the 1999–2001 Biennium

Field data for the Flathead Lake Area study were evaluated and interpreted. Three Open-File maps describing the hydrogeology of the Flathead Lake Area were released and 4 other maps were completed and are in review. Selected wells monitored for water levels during the Flathead Lake Area study were transferred to the Ground-Water Monitoring Program's statewide monitoring network.

Plans for the 2001–2003 Biennium

The manuscript for Montana Ground-Water Assessment Atlas No. 2: Ground-Water Resources of the Flathead Lake area: Flathead, Lake, and part of Sanders counties, Montana; Part A– Descriptive overview, will be completed, reviewed, and submitted for publication. Another six hydrogeologic maps, in addition to those already released or in review, will be completed.

Information Products

LaFave, J.I., 1999, A tale of two valleys: Hydrogeology of the Kalispell and Mission valleys, Abstract, American Water Resources Association Montana Section meeting, Great Falls, Montana.

LaFave, J.I., 2000, Status of ground-water level monitoring sites Kalispell valley (upper Flathead River Valley), Northwest Montana. Montana Ground-Water Assessment Open File Report GWOF 14, 1:200,000.

LaFave, J.I, 2000, Potentiometric surface map of the deep aquifer, Kalispell valley: Flathead County, Montana. Montana Ground-Water Assessment Atlas No. 2, Part B, Map 2 (open file version), 1:63,360.

Smith, L.N., 1999, Geologic framework of aquifers and confining units in the Flathead River watershed, Flathead, Lake and parts of Sanders and Missoula counties, Montana. Abstract, American Water Resources Association Montana Section meeting, Great Falls, Montana.

Smith, L.N., 2000, Surficial geologic map of the upper Flathead River valley (Kalispell valley): Flathead County, Montana. Montana Ground-Water Assessment Atlas No. 2., Part B, Map 6 (open file version), 1:70,000.

Project Title: Middle Yellowstone River Area Ground-Water Characterization Study

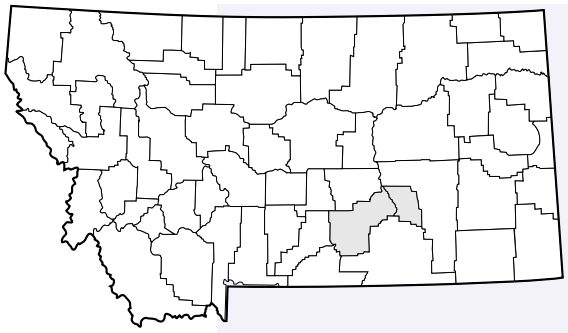
Location: Yellowstone and Treasure Counties, exclusive of the Crow Reservation

Period of Project: July 1996–June 1999

Project Leader: Tom Patton

Project Staff: John LaFave, Larry Smith, Camela Carstarphen, Don Mason, James Rose, Jon Reiten, John Olsen, and Joe Lalley

Funding Sources: Montana Bureau of Mines and Geology, Ground-Water Assessment Program



Issue

Insufficient information is hampering efforts to properly manage, protect, and develop ground-water resources.

Objective

Provide information to landowners and decision makers about management, protection, and development of ground-water resources by systematically assessing and documenting the hydrogeology and quality of individual aquifers.

Approach

Compile information on the geology and ground-water resources, map aquifer distributions, visit selected wells to measure water levels and basic water-quality parameters, conduct additional testing to determine aquifer properties, and collect and analyze ground-water samples to evaluate water quality and better understand ground-water flow systems.

Progress during the 1999–2001 Biennium

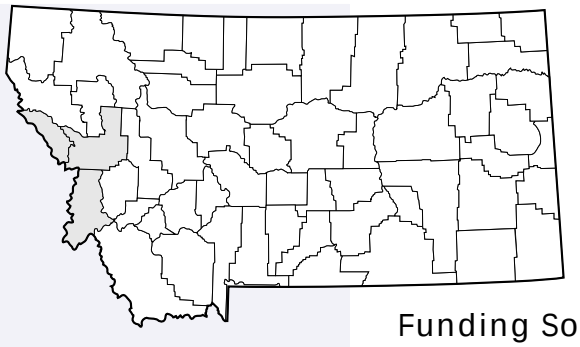
Information collected from 1,022 wells was reviewed and evaluated. Monthly monitoring of water levels in about 90 wells continued. Data interpretation and map development for Montana Ground-Water Assessment Atlas No. 3 was assigned to the MBMG Billings office.

Plans for the 2001–2003 Biennium

Monthly monitoring of water levels in wells will continue until December 2000. After December 2000, selected wells will be transferred to the Ground-Water Monitoring Program for continued quarterly monitoring. Map products for Ground-Water Assessment Atlas No. 3 will start becoming available late in the 2000–2001 biennium.

Information Products

Hydrogeologic data obtained from the visitation of wells and current static-water level data for monitored wells are available to Montana citizens from the Ground-Water Information Center data base.



Project Title: Lolo-Bitterroot Area Ground-Water Characterization Study

Location: Mineral, Missoula, and Ravalli Counties

Period of Project: July 1998–June 2001

Project Leader: Tom Patton

Project Staff: John LaFave, Larry Smith, Camela Carstarphen, Don Mason, Mike Richter, Karl Pracht

Funding Sources: Montana Bureau of Mines and Geology, Ground-Water Assessment Program

Issue

Insufficient information is hampering efforts to properly manage, protect, and develop ground-water resources.

Objective

Provide information to landowners and decision makers about management, protection, and development of ground-water resources by systematically assessing and documenting the hydrogeology and quality of individual aquifers.

Approach

Compile information on the geology and ground-water resources, map aquifer distributions, visit selected wells to measure water levels and basic water-quality parameters, conduct additional testing to determine aquifer properties, and collect and analyze ground-water samples to evaluate water quality and better understand ground-water flow systems.

Progress during the 1999–2001 Biennium

Characterization program staff visited about 860 wells within the Lolo-Bitterroot Area study and collected 261 new water quality samples. Water levels were measured monthly in 86 wells throughout the study area.

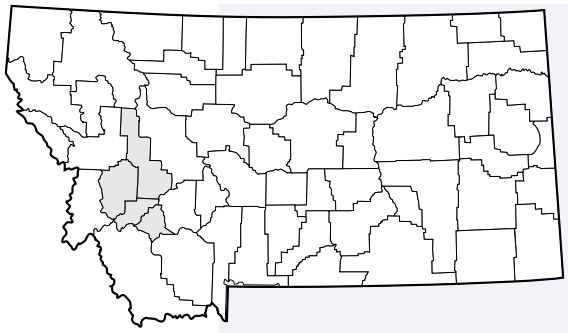
Plans for the 2001–2003 Biennium

When work on Flathead Lake Area maps is complete, staff will begin interpreting data for the Lolo-Bitterroot Area.

Information Products

Hydrogeologic data obtained from the visitation of wells and current static-water level data for monitored wells are available to Montana citizens from the Ground-Water Information Center data base.

Project Title: Upper Clark Fork River Area Ground-Water Characterization Study



Location: Deer Lodge, Granite, Powell, and Silver Bow Counties

Period of Project: July 2000–June 2003

Project Leader: Tom Patton

Project Staff: John LaFave, Larry Smith, Camela Carstarphen, Don Mason, Mike Richter, and Leonard Rinehart

Funding Sources: Montana Bureau of Mines and Geology, Ground-Water Assessment Program

Issue

Insufficient information is hampering efforts to properly manage, protect, and develop ground-water resources.

Objective

Provide information to landowners and decision makers about management, protection, and development of ground-water resources by systematically assessing and documenting the hydrogeology and quality of individual aquifers.

Approach

Compile information on the geology and ground-water resources, map aquifer distributions, visit selected wells to measure water levels and basic water-quality parameters, conduct additional testing to determine aquifer properties, and collect and analyze ground-water samples to evaluate water quality and better understand ground-water flow systems.

Progress during the 1999–2001 Biennium

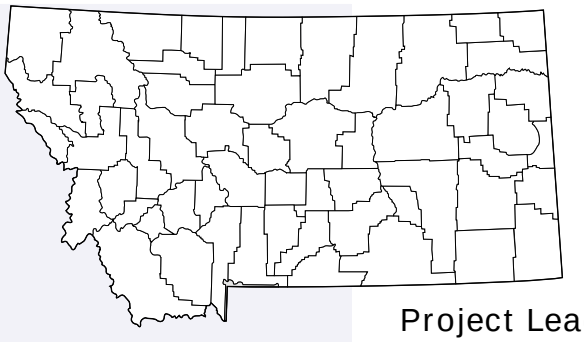
An expanded network of monitoring wells for monthly water level measurements was established beginning in March 2000. Water-quality samples were collected from the monitoring wells. Visitation of selected wells began primarily in northern part of the study area within the Blackfoot River drainage. Office verification of the Ground-Water Information Center databases for Deer Lodge, Granite, Powell, and Silver Bow counties was completed.

Plans for the 2001–2003 Biennium

Monthly monitoring of water levels in wells will continue throughout the biennium. Field visits to wells will be finished by October 2001. Preparation of a basic data map will begin and be available by the end of the biennium.

Information Products

Hydrogeologic data obtained from the visitation of wells and current static-water level data for monitored wells are available to Montana citizens from the Ground-Water Information Center data base.



Project Title: Yellowstone Controlled Ground-Water Area Well Inventory and Baseline Sampling

Location: Southwest Montana near Yellowstone National Park

Period of Project:

Specific Task Agreement: July 1994–June 2000

Cooperative Agreement: July 1994–June 1999

Project Leader: John Metesh

Project Staff: Jodey Kougioulis, Alan English

Funding Source: National Park Service

Problem

Development of ground-water resources near Yellowstone Park may adversely affect the geothermal resources of the park. The National Park Service has entered into a cooperative agreement with the Bureau to conduct a well inventory and to collect baseline water-quality data for the controlled ground-water area.

Objectives

To collect locations, water levels, and field-chemistry data for all existing wells and to collect baseline water-quality data for selected wells in the Yellowstone controlled ground-water area.

Approach

1. Update information for each well contained in the MBMG Groundwater Information Center data base.
2. Conduct a door-to-door field inventory of all wells in the area.
3. Inventory all new wells in the area as they are completed.
4. Select and sample wells for water quality and isotope analysis throughout the area. Wells will be selected for sampling based on water temperatures, field chloride contents, and the aquifers in which they are located.

Progress during the 1999–2001 Biennium

The well inventory and baseline sampling in all areas are complete. A final report was submitted to the technical oversight committee and approved. The MBMG will publish the results in the spring of 2000.

Plans for the 2001–2003 Biennium

The projBaseline sampling of the entire compact area will be completed by the end of 1998. A final report summarizing the inventory and sampling results will be prepared at that time.

Information Products

MBMG Report of Investigation 8; inventory and water-quality data reside in the Bureau's Ground-Water Information Center data base.

Project Title: Yellowstone Controlled Ground-Water Area Spring Inventory and Watershed Analysis

Location: Southwest Montana near Yellowstone National Park

Period of Project:

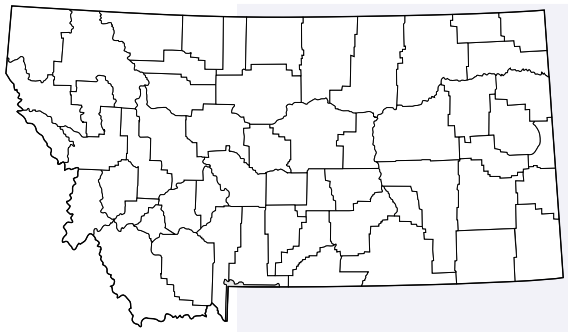
Specific Task Agreement: July 1998–June 2001

Cooperative Agreement: July 1994–June 1999

Project Leader: John Metesh

Project Staff: Jodey Kougioulis, Alan English

Funding Source: National Park Service



Problem

Development of ground-water resources near Yellowstone Park may adversely affect the geothermal resources of the park. The National Park Service has entered into a cooperative agreement with the Bureau to conduct a spring inventory and to collect baseline water-quality data for watersheds within the controlled ground-water area.

Objectives

To collect location and field-chemistry data for all existing springs and to collect baseline water-quality data for the eight major watersheds within the Yellowstone controlled ground-water area.

Approach

1. Update information for each spring contained in the MBMG Groundwater Information Center data base.

2. Inventory all active springs in the area.

3. Select and sample springs for water quality and isotope analysis throughout the area.

Progress during the 1999–2001 Biennium

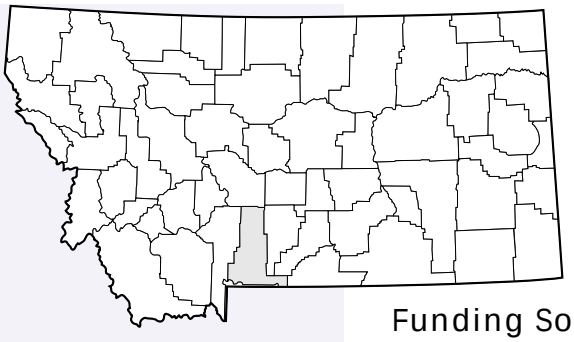
Springs have been inventoried in the Soda Butte Creek basin and the upper Yellowstone basin near Gardiner, Montana.

Plans for the 2001–2003 Biennium

The spring inventory and baseline sampling are expected to be completed in 2000. A final report will be prepared in the spring of 2001.

Information Products

All inventory and chemistry data are available through the MBMG Ground-Water Information Center.



Project Title: Soda Butte Creek Hydrogeologic Investigation

Location: Park County

Period of Project: September 1996–December 1999

Project Leader: John Metesh

Project Staff: Jon Reiten, Alan English

Funding Source: National Park Service

Issue or Background

In 1994, the Secretary of the Interior and the Governor of the State of Montana signed a compact regarding the water rights of several National Park units. As a result of the administrative procedures established in the compact, the Montana Department of Natural Resources and Conservation notifies the National Park Service's Water Resources Division of applications for beneficial ground-water use in designated areas adjacent to the park units. The National Park Service (NPS) then has the opportunity to evaluate the proposed appropriation and determine whether it will withdraw ground water that is hydrogeologically connected to a surface stream. The NPS requires information to make this determination.

The NPS requested the Montana Bureau of Mines and Geology and the U.S. Geological Survey (USGS) to evaluate scientific literature and data regarding the hydrogeology, ground-water hydrology, and surface-water hydrology of the upper Soda Butte Creek basin near the northeast corner of Yellowstone National Park, and describe the hydrogeologic system (ground-water and surface-water) of the basin, including ground-water/surface-water relationships.

Objective

The report will be used to make decisions related to surface- and ground-water appropriations within the upper Soda Butte Creek drainage. The information will be available to the state, sederal, and public entities.

Approach

Existing literature and data pertaining to the hydrogeology of the Soda Butte Creek drainage will be compiled. New data pertaining to ground-water (water-levels, aquifer characteristics, and water-quality) were collected by the MBMG. Stream flow and water-quality data were collected by the USGS. The MBMG will summarize the investigation and evaluate the ground-water / surface-water relationship with respect to ground-water development in the area.

Progress during the 1999–2001 Biennium

The investigation was completed. A joint MBMG-USGS report was submitted to the National Park Service. The final report was published by the MBMG as Report of Investigation 7.

Plans for the 2001–2003 Biennium

No additional activities are planned.

Information Products

Hydrogeology of the Upper Soda Butte Creek Basin, Montana, MBMG RI 7.

Project Title: Water Resources of the Upper Pryor Creek Watershed

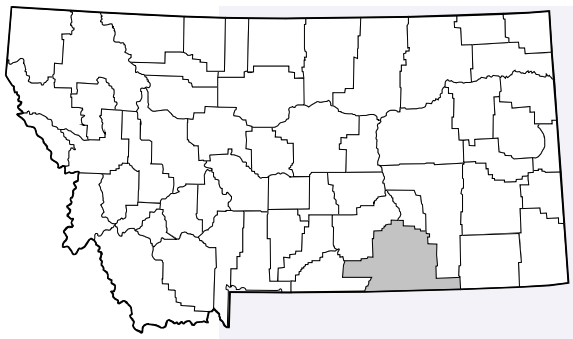
Location: Pryor, Montana

Period of Project: 1989–Present

Project Leader: John Wheaton

Project Staff: David Lopez

Funding Source: U.S. Bureau of Indian Affairs



Problem

Thousands of acres in the upper Pryor Creek basin are irrigable, but the quantity of available surface water is inadequate. Ground-water supplies, if they are of sufficient quantity and quality, would provide a valuable supplement to surface-water supplies.

Objectives

Investigate and document the quality and quantity of ground water in the alluvium and in bedrock aquifers. Determine the relationship between the ground-water and surface-water systems. Interpret the data to describe the water available for irrigation and other uses in the upper Pryor Creek area.

Approach

Conduct inventory of existing wells and springs in the area. Install monitoring wells in the alluvium and Pryor conglomerate. Measure water levels, perform aquifer tests and collect water-quality samples. Develop a mass balance describing the ground-water flux in the area. Map the surface geology and interpret the subsurface geology.

Progress during the 1999–2001 Biennium

Final report was published.

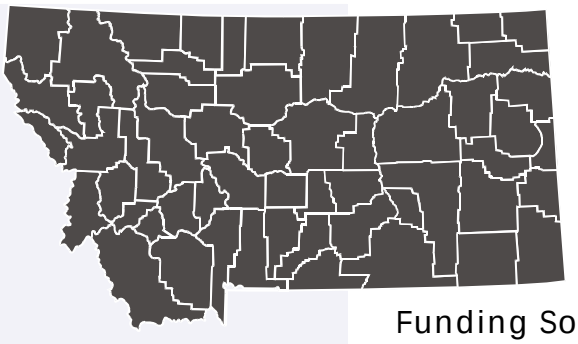
Plans for the 2001–2003 Biennium

This project is completed; however, due to other hydrogeologic issues on the Crow Indian Reservation such as expected coal-bed methane development, this agreement has been continued. This will allow the MBMG to provide technical assistance to the reservation and to the Bureau of Indian Affairs as needed.

Information Products

Wheaton, J.R., 1993, Water resources of the upper Pryor Creek basin, Crow Indian Reservation, south-central Montana, Interim Project Report, 13 p.

Wheaton, J.R., and Lopez, D.A., 1999, Hydrogeology of the upper Pryor Creek basin, Big Horn and Yellowstone counties, Montana, Montana Bureau of Mines and Geology Report of Investigation 5, 26 p.



Project Title: Drinking Water Assistance Center Source-Water Protection Plan: Demonstration Sites, Guidance Document, and Training Module

Location: State Wide

Project Period: June 1995–September 1998

Project Leader: Kathleen Miller

Project Staff: Peter Norbeck, Jon Reiten

Funding Source: Montana University System, Water Resources Research Center

Problem

Ground water is the source of most small public drinking-water supplies in Montana. One of the most effective tools for providing long-term drinking-water quality is to prepare water protection plans for ground-water sources. However there are few Department of Environmental Quality-certified plans in place.

Objective

Assist small, public drinking-water systems by writing a statewide technical guidance document that outlines techniques for preparing source-water protection plans. Provide four communities with geotechnical services in delineating source-water protection boundaries.

Approach

The communities of Dillon, Fairfield, Hillside Hutterite Colony, and Sidney were chosen as demonstration sites for the program. Detailed geotechnical evaluations were performed to delineate source-water protection boundaries. Results from the geotechnical evaluations at the demonstration sites were incorporated into a state wide technical guidance document and training module.

Progress during the 1999–2001 Biennium

Project completed.

Information Products

Miller, K.J., Meek, J., Norbeck, P.M., and Reiten, J., 1998, Montana Source Water Protection Technical Guidance Manual, MBMG 378, 281 p.

Montana Water Center and Miller, K.J., 1998, Montana Source Water Protection Technical Guidance CD-ROM.

Project Title: Hydrologic Assessment of Rosebud and East Fork Armells Creeks, Rosebud County, Montana

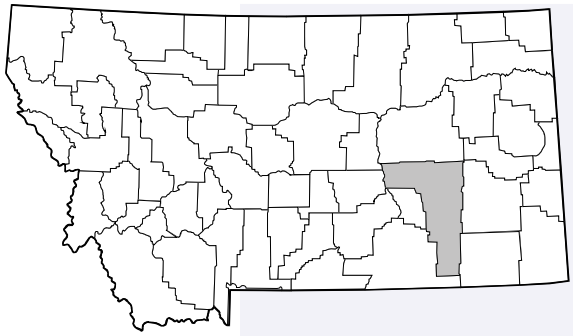
Location: Near Colstrip, Montana

Period of Project: July 1998–December 2000

Project Leader: John Wheaton

Project Staff: John Olson, field technicians, and students

Funding Source: Department of Environmental Quality through the 319 program



Issue

The Montana Section 303(d) list shows a variety of nonpoint source (NPS) impacts to Rosebud Creek and East Fork Armells Creek. The type, location, and source of impacts are not currently documented, but are expected to come from various sources, including mining, agriculture, and natural sources. Mine spoils may play an important role in the watersheds. Best management plans (BMP) are needed and can only be designed based on a thorough understanding of the watershed hydrogeology and the role of the mine spoils, and other potential impacts.

Objectives

The major goal of the project is to document changes that have occurred in Rosebud and East Fork Armells creeks since the 1970s, to begin developing plans to maintain the viability of the water resource and choose locations for future implementation of NPS controls. Hydrologic controls on stream flow and water quality that will be investigated include land use in areas that recharge ground water systems such as coal strip mining, and agricultural practices adjacent to streams. Specifically, the role of ground-water discharge from coal-mine spoils aquifers will be evaluated as to its role in surface-water quality issues.

Approach

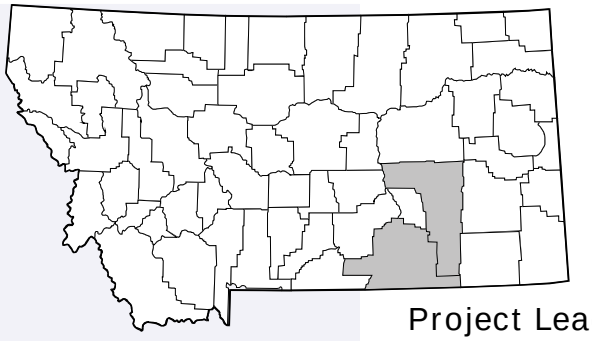
The conservation district and local landowners provide guidance and direction for the project. Existing data are being compiled from sources that include 25 years of MBMG data for some wells, company data, DEQ records, USGS surface-water data, and NOAA meteorological records. A monitoring program has been established and gain/loss surveys performed along with collection of water samples. Data are plotted and analyzed throughout the project. Results of the project will include a report, field trips, and workshops.

Progress during the 1999–2001 Biennium

Streamflow measurements, water-quality sampling and ground-water levels have occurred and been added to the database. Existing data have been compiled. Benthic insect and stream channel stability survey is completed for Rosebud Creek.

Plans for the 2001–2003 Biennium

Continue streamflow and water-quality monitoring and import the remainder of existing data into watershed data base. MBMG staff will write reports and lead field trips along with Rosebud Conservation District.



Project Title: Start-up: Assessment of Nonpoint Source Pollution to Water Resources of the Upper Tongue River in Big Horn and Rosebud Counties, Montana

Location: South-Central Montana from the Wyoming State Line to Birney, Montana

Period of Project: January 2000–January 2001

Project Leader: John Wheaton

Project Staff: Students and technicians in Billings Office

Funding Source: Department of Environmental Quality through the 319 Grant Program

Issue

The Tongue River is included on the TMDL list (EPA 303[d]) as being impaired by flow alterations, elevated levels of metals, other inorganics, salinity, TDS, chlorides, and suspended solids. Beneficial uses listed as being impaired include agriculture, aquatic life support, warm water fishery and cold water fishery trout. (Montana List of Water Bodies in Need of Total Maximum Daily Load Development, DEQ 1998). Listed as probable sources of impacts are agriculture, regulation of flow (Tongue River Reservoir), irrigated crop production, and natural sources. Likely impacts that are not listed include coal-strip mining, raising the stage of the Tongue River Reservoir, Tongue River Railroad, and coal-bed methane development.

Objectives

The major goal of this project is to develop a water-quality project to assess impacts and trends for the Tongue River from the state line to the town of Birney. It is envisioned that this will be the first of several NPS projects along the Tongue River. Due to the size and length of the river, it is necessary to direct work along specific sections based on land use, potential impacts and geology. A watershed plan will be designed during this project. Alterations to water quality and quantity within the proposed reach of the river include the largest coal-strip mines in Montana, coal bed methane development, the Tongue River Railroad, and reconstruction and enlargement of the Tongue River Dam. Watershed planning for the Tongue River must involve Big Horn, Rosebud, and Custer conservation districts, and other interested groups. This project is necessary to coordinate concerns from these groups, and to write proposals to begin assessing the watershed.

Approach

Interested parties and concerns will be identified. Existing data will be compiled, and a preliminary inventory of current conditions will be performed. A watershed plan will be developed, and funding proposals for future assessment work submitted. The end result will be coordinated proposals.

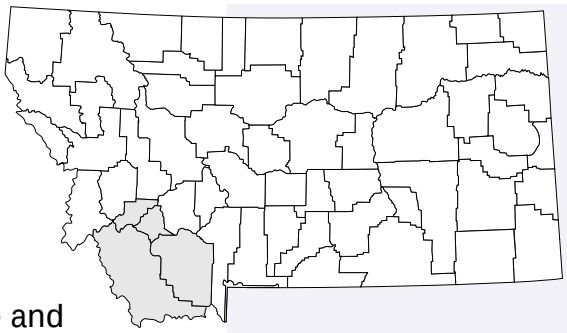
Progress During the 1999–2001 Biennium

The project contracts were prepared and signed, and work on the projects will begin during summer 2000.

Plans for the 2001–2003 Biennium

Field work, data compilation and project coordination will occur during the next biennium.

Project Title: Big Hole River Return Flow and Water Budget Investigation



Location: Big Hole Basin of SW Montana, including parts of Beaverhead, Deer Lodge, Silver Bow, and Madison Counties

Period of Project: August 1997–June 2000

Project Leader: Richard Marvin

Project Cooperators: Terry Voeller (Natural Resource and Conservation Service), Ron Shields (U.S. Geological Survey), Rick Blaskovich and Kim McCartney (U.S. Bureau of Reclamation), Garth Haugland (Beaverhead County Board of Commissioners)

Funding Sources: Montana Renewable Resource Grant Program, U.S. Bureau of Reclamation, U.S. Geological Survey, DNRC Water Resources Division, Beaverhead County Board of Commissioners, George Grant Chapter of Trout Unlimited, Big Hole River Foundation, Montana Bureau of Mines and Geology

Issue or Background

During the past three decades, several late-summer droughts have caused serious dewatering of the Big Hole River. Conditions in August and September 1988 were so severe that no flow was recorded at the U.S. Geological Survey (USGS) gaging station at the town of Wisdom. In the summer 1994, drought led to a temporary ban on fishing to protect the river's trout and fluvial Arctic grayling fisheries. Not surprisingly, water use in the basin, particularly by agricultural interests, has come under close scrutiny. For generations water has been diverted from the river for irrigation and stock watering. Many water users believe that return flows from the diversions greatly benefit the river in the late summer; others are skeptical of this supposition. This investigation was initiated at the request of the Big Hole Watershed Committee and will clarify the relationship between return flows and surface-water flow in the Big Hole basin. The project also will provide insight concerning the overall water resources and water budget of the basin.

Objectives

To characterize return flow contributions within selected portions of the Big Hole drainage and determine water budgets for these areas. To assist the Big Hole Watershed Committee with interpretation of the data and with implementation of best water-management practices.

Approach

1. Gather flow data from the Big Hole River and select tributaries in the upper and lower Big Hole basin.

2. Characterize the near-surface aquifer by collecting water-level data, logging new wells, and performing aquifer tests.

3. Monitor meteorological conditions (temperature, precipitation, and wind velocity) within the basin.

4. Determine water budgets for the study areas and compare water inflow to outflow to arrive at estimates of return flow contributions to river flow.

5. Attend Big Hole Watershed Committee meetings to provide technical assistance.

6. Prepare and publish reports as well as present findings at public and scientific meetings.

Progress during the 1999–2001 Biennium

Compiled data collected in 1997 and 1998, and prepared a final report. Presented project findings to the Big Hole Watershed Committee and to the Montana Section of the American Water Resources Association. Provided technical assistance to the Big Hole Watershed Committee.

Plans for the 2001–2003 Biennium

Develop a computer model to evaluate how water resource changes may affect the hydrology of the basin. Initiate a long-term monitoring program to track surface-water and ground-water quality within the basin.

Information Products

Marvin, R.K., 1997, Ground-water/surface-water interactions in the upper Big Hole basin, Montana: Montana Bureau of Mines and Geology Open-File Report 349, 58 pp. plus appendixes.

Marvin, R. K., 1997, Irrigation return flow model for an idealized portion of the upper Big Hole basin, southwest Montana: 1997 Montana Section of the American Water Resources Association and Montana University System Water Center, Abstracts with Program, Butte, Montana, October 2–3, 1997.

Marvin, R.K., and Voeller, T. L., 2000, Hydrology of the Big Hole basin and an assessment of the role of irrigation returns: Montana Bureau of Mines and Geology Open-File Report (In review).

Marvin, R.K., and Voeller, T., 1999, Irrigation return flows in the Big Hole basin, southwest Montana: 1999 Montana Section of the American Water Resources Association and Montana University System Water Center, Abstracts with Program, Great Falls, Montana, October 4–5, 1999.

Project Title: Pesticides in Ground Water and Surface Water on the Greenfields Bench Montana

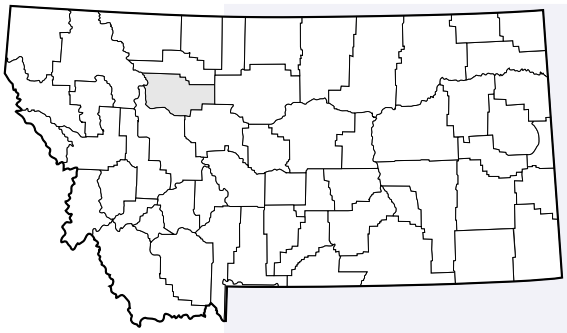
Location: Teton County

Period of Project: July 1997–November 2001

Project Leader: Kathleen Miller

Project Staff: Katie McDonald, Mary Hendrickson

Funding Sources: Department of Environmental Quality/Teton County Conservation District/DNRC



Issue

Pesticides have been detected in public and private drinking water supplies and in surface water on the Greenfields Bench.

Objectives

1) Characterize the extent of pesticide contamination and range of concentrations in ground water and surface water; 2) determine whether the contamination and concentration constitute a health risk; 3) evaluate aquifer contamination potential based on irrigation methods and farming practices.

Approach

Quarterly pesticide sampling of 16 selected wells and 9 surface-water sites and characterization of hydrogeology on the Greenfields Bench. Using two field-size study plots, compare sprinkler irrigation with flood irrigation for relative propensity to leach pesticide to ground water.

Progress during the 1999–2001 Biennium

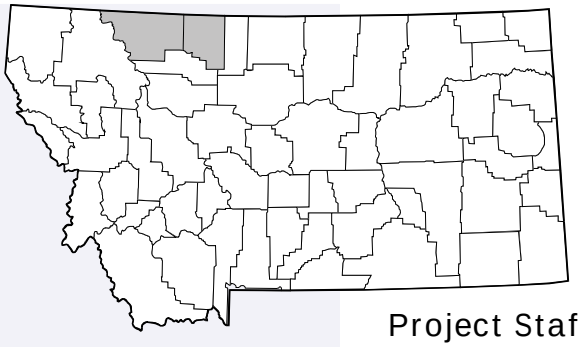
Data collection complete on Bench-wide ground water and surface water.

Plans for the 2001–2003 Biennium

Complete data collection for field-size study plots.

Information Products

Final report will be prepared and submitted for MBMG publication and inclusion in Montana Department of Agriculture Specific Management Plan.



Project Title: Evaluation of Non-Point Source Pollution in the Red River Watershed, Glacier and Toole Counties, Montana

Location: Northern Glacier and Toole Counties, Montana

Period of Project: June 1995–June 1997

Project Leader: Kathleen Miller

Project Staff: Peter Norbeck, Roger Torgersen

Funding Sources: Environmental Protection Agency, Department of Environmental Quality, 319 Glacier County Conservation District, Montana Bureau of Mines and Geology

Issue

Glacier and Toole counties in northwestern Montana contain thousands of oil and gas wells and are two of the leading oil- and gas-producing counties in Montana. The area also is a major producer of dryland wheat and barley. These activities have caused numerous concerns of surface-water and ground-water contamination resulting from saline seep, leaking brine pits, and poor oil-well completion and abandonment practices.

Objective

Evaluate and characterize the hydrologic regime, surface-water and groundwater interaction, and extent of ground-water contamination from activities contributing to non-point source pollution of surface water and ground water in the 138,000 acres in and adjacent to the Red River valley watershed. This project constitutes phase I of an overall watershed plan; phase II will be the implementation of best management practices and some site cleanup.

Approach

Evaluate current surface-water and ground-water quality data and compare them with historical data to determine the presence or absence of water-quality trends. Samples were collected from selected wells and analyzed for pesticides. The evaluation will provide baseline data to assist in future watershed planning and will provide the necessary information for dissemination in public education seminars sponsored by the Glacier County Conservation District. Water wells, oil wells, and injection wells were inventoried and mapped. Hydrogeologic investigations were performed at selected sites. Ground-water occurrence, flow, and non-point source pollution potential was assessed, with particular emphasis on ground water that discharges to the Red River and on those aquifers used as a drinking-water supply.

Progress during the 1999–2001 Biennium

Project completed and final report prepared.

Information Products

Norbeck, P.M., and Miller, K.J., 2000, Evaluation of Non-point Source Pollution in the Red River Watershed, Glacier and Toole Counties, Montana, MBMG 396, 52 p., plates and appendixes.

Project Title: Water Resource Evaluation of the Sage Creek Watershed

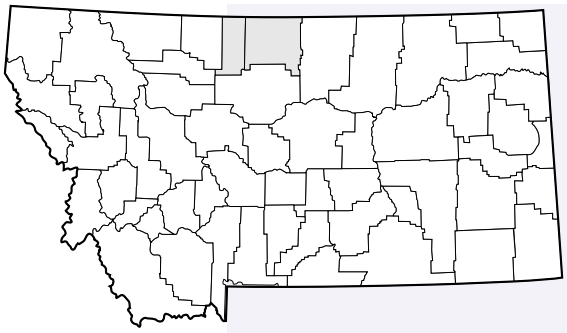
Location: Hill and Liberty Counties

Period of Project: September 1997–June 2002

Project Leader: Kathleen Miller

Project Staff: Katie McDonald, Mary Hendrickson

Funding Sources: Department of Environmental Quality/Hill County Conservation District



Issue

Degradation of water quality in Sage Creek has made it unusable for irrigation. Sage Creek flows into Big Sandy Creek and Milk River, causing further degradation of those drainages.

Objective

Determine affect of ground-water and surface-water interaction on water quality in Sage Creek.

Approach

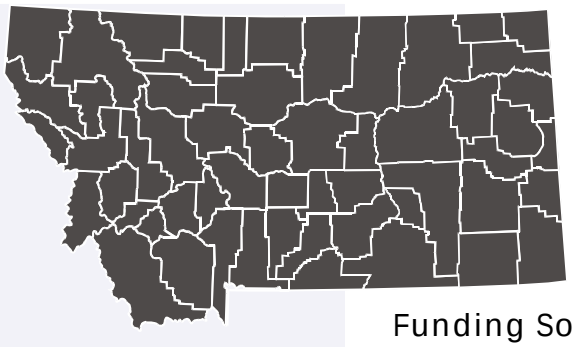
Characterize hydrogeology with well inventory and sampling; characterize stream flow characteristics using data loggers, crest-stage gauges and water-quality sampling.

Progress during the 1999–2001 Biennium

Data collection complete on middle portion of Sage Creek.

Plans for the 2001–2003 Biennium

Begin data collection on lower portion of Sage Creek, include data on entire watershed. Begin report preparation.



Project Title: Ground-Water Education and Protection for Rural Montana Schools

Location: Participating schools that are representative of the state's diverse land uses and geologic and hydrogeologic environments

Period of Project: January 1997–June 2001

Project Leader: Ginette Abdo

Funding Source: Montana Department of Natural Resources and Conservation

Issue

The Safe Drinking Water Act (SDWA) Amendments of 1996 required states to develop and implement Source Water Protection Programs to analyze existing and potential threats to the quality of public water supplies. Source water protection is a common-sense approach to guarding public health by protecting drinking water. Schools classify as non-transient non-community public water supplies and therefore fall under the Source-Water Protection Program.

Objective

The objective of this project is to enhance protection of ground-water drinking supplies through education and instilling an awareness and understanding of groundwater as a resource in our school system.

Approach

The MBMG has been directly involved with the participating schools by teaching classes, supervising student field work, and assisting the students write a source water protection plan for their school's drinking water supplies.

Progress during the 1999–2001 Biennium

Draft Source Water Protection Plans for the Canyon Creek and Ramsay Schools were completed.

Plans for the 2001–2003 Biennium

Finalize the draft plans and work with two additional schools to help them develop a Source Water Protection Plan for their drinking water.

Information Products

By the end of the project their will be a Source Water Protection Plan for each of the four participating schools.

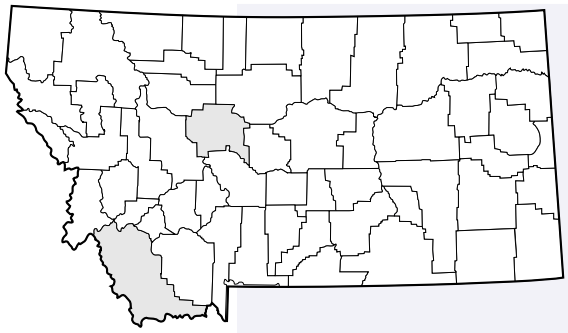
Project Title: A Study to Test the Effects of Water Quality on UV Disinfection in Small Montana Public Water Systems

Location: Cascade and Beaverhead Counties

Period of Project: 1997–2000

Project Leaders: Ginette Abdo, Barb Keller

Funding Sources: Environmental Protection Agency and Montana University System Water Center



Issue

Amendments to the 1986 Safe Drinking Water Act (SDWA) have required the US Environmental Protection Agency (EPA) to develop new regulations for the microbiological content of groundwater. Because small public water systems do not have substantial technical and financial resources, it is expected that these water systems will have difficulty complying with the new requirements unless the disinfection technology is a simple, low-cost technique that is easily operated and readily available. One technology that meets these criteria is ultraviolet (UV) light disinfection. The performance of an UV disinfection system is directly related to UV light absorbance by the treated water. Several factors in the water that can adversely affect the performance of an UV disinfection unit are hardness, iron, manganese, sulfites, nitrites, and aromatic organics. These water-quality parameters are known to cause plating where the surface of the UV quartz sleeves are covered with a layer of minerals. Plating can cause inadequate transmittance of the UV light, and therefore, a decrease in microbial inactivation efficiency. Additionally, suspended solids/precipitates can scatter the UV light, an effect that can prevent the light from reaching the target organisms.

Objective

The objective of this study was to evaluate the performance of a commercially available UV disinfection unit under varying conditions of water quality at four locations in Montana. Each of the four water supplies had varying concentrations of iron, manganese, sulfate, and water hardness.

Approach

Identical UV units were installed at each location. Water samples were collected biweekly for a 6–10-month period. Samples were collected before the UV unit and after the UV unit. The before and after samples were analyzed for iron, manganese, sulfate, pH, total coliform, heterotrophic plate count (HPC) and major cations and anions. Additionally, the intensity of the UV lamp and the water flow through the units were recorded biweekly at each site.

Progress during the 1999–2001 Biennium

The project was completed in November 2000. Overall, HPC, which is an indicator of the cultivable organisms present in the water, was statistically reduced in water after passing through the UV unit at the Sun Praire Village, Gore Hill, and H-J water systems. Organism removal efficiency was highest at Sun Prairie Village (91%), suggesting that the high concentrations of sulfate, manganese, and total dissolves solids present at this site had little effect on disinfection efficiency. The lowest removal efficiency was at the Gore

Hill water supply, which may indicate that the higher iron and hardness was influencing how well the UV process worked. The ability of the UV unit to disinfect groundwater under these extreme conditions was somewhat surprising but nevertheless encouraging for small public water supplies who propose to employ UV disinfection as their technique for disinfecting drinking water.

Visual inspection of the quartz sleeves, which house the UV lamps, after the end of the test period indicated that plating had occurred at all sites. This was confirmed by analyses of the quartz sleeve filter wipes. Although plating decreases UV intensity, this was not reflected in the intensity meter readings, raising suspicion as to the accuracy of the intensity meter.

Information Products

A draft report has been submitted for internal review and will be published as a Bureau Open-File report and will also be sent to the funding agency. This information has been presented at the 67th Annual Water School for Water and Wastewater Operators and Managers on September 26, 2000, in Bozeman, Montana.

Project Title: Radon in Ground Water in Montana and Geologic Interpretation of Air and Water Data

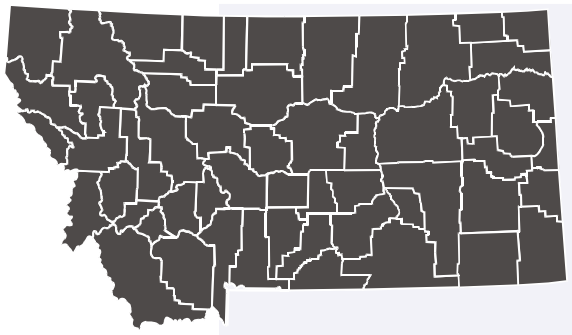
Location: State Wide

Period of Project: July 1995–September 1998

Project Leader: Kathleen Miller

Project Staff: Peter Norbeck, Joel Hall, Greg Schmidt, Michael Coffey

Funding Source: Montana Department of Environmental Quality



Issue

Radon in water can be a significant source of radon in indoor air. Because little radon-in-ground-water information exists in Montana, a state-wide data base has been established. Scanning, vectorization, and post-processing of various geologic maps were performed to provide geology in a digital format.

Objective

To augment the radon-in-ground-water data base portion of Ground-Water Information Center with radon analyses from selected public water supplies. Also to provide digital format for the following geologic maps: at 1:250,000, Butte, Dillon, Kalispell, and Wallace; at 1:250,000, Baker, Chester, Miles City, Sidney, Sweet Grass Hills, and Wibaux aat 1:100,000 for use of a map base.

Approa ch

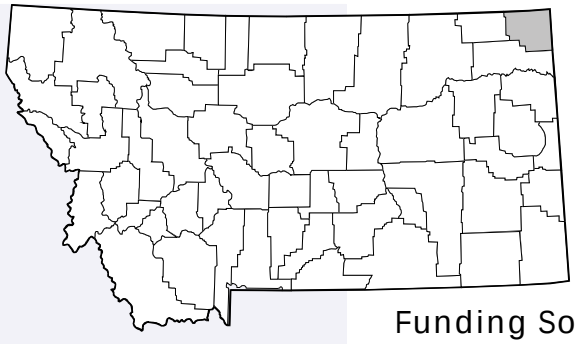
Public water-supply operators were asked to collect radon samples from well heads. Samples were analyzed by the MBMG Analytical Division; results were entered into GWIC at MBMG, and then mailed to the public water department suppliers and to DEQ. Geologic maps available on a stable base were scanned, vectorized, post-processed, and plotted on paper.

Progress during the 1999–2001 Biennium

Publication completed.

Information Products

Miller, K.J. and Coffey, M.A., 1998, Radon and You: Promoting Public Awareness of Radon in Montana's Air and Ground Water, IP3, 16 p.



Project Title: Sheridan Co. Aquifer and Surface Water Monitoring & Modeling

Location: Sheridan County

Period of Project: September 1997–June 2002

Project Leader: Jon Reiten

Project Staff: Teresa Donato, MSU-B students, Sheridan County Conservation District Staff (SCCD)

Funding Sources: DNRC/RIT/SCCD/ US Fish and Wildlife Services

Issue or Background

The Sheridan County Conservation District (SCCD) has been authorized to develop up to 5809 acre-feet of ground water out of the Clear Lake aquifer as part of a water reservation. Once this volume of water has been developed, an additional 10,000 acre-feet of water may be opened for future development. A technical advisory committee was established to evaluate permit applications from potential irrigators. The committee requires a large amount of information on water quality, water availability, soil/water compatibility, potential impacts to wetlands, and project engineering to evaluate each permit application. If no adverse impacts are determined likely, the committee recommends that the SCCD approve the permit. A long-term goal is to develop the water resources without causing significant impacts to other resources in the region.

Objective

Promote economic development in an agricultural region by safely developing the Clear Lake aquifer for irrigation without harming the regions wetlands and water bodies associated with the Medicine Lake Wildlife Refuge.

Approach

To evaluate impacts to other irrigators, lakes, and wetlands the SCCD has developed a monitoring program to determine causes of water-level fluctuations in the aquifer. Over 100 wells and surface water sites are monitored on frequencies ranging from continuous to semi-annual. Climatic records and water use records are compiled to compare to these records to the water-level fluctuations.

Progress during the 1999–2001 Biennium

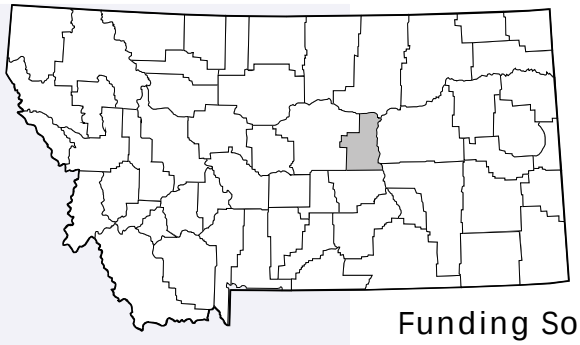
Continued monitoring water levels, periodically updated monitoring databases, produced hydrographs, produced plots of climatic trends, produced plots of water use and used these data to evaluate several additional water permit applications. Wrote several reports evaluating impacts of current status of irrigation. Drilled an additional 10 monitoring wells and collected and analyzed water samples from these and several other wells.

Plans for the 2001–2003 Biennium

Continue monitoring and assessing aquifer conditions with respect to additional irrigation. Evaluate models and collect additional data as required.

Information Products

Project completion reports and Open file reports. GIS maps are being developed showing hydrogeology, water resources, and status of ground water development. It is anticipated that some or all of this information will be loaded onto the District's web site.



Project Title: Rehabilitating Flowing Wells in Petroleum County

Location: Petroleum County

Period of Project: July 1996–February 1999

Project Leader: Jon Reiten

Project Staff: Mike Brayton, Montana Tech graduate student; Teresa Donato

Funding Sources: Private landowners, Petroleum County Conservation District, Montana Department of Natural Resources and Conservation, Montana Bureau of Mines and Geology

Problem

Landowners have noticed a decline in aquifer pressure and productivity. This decline is caused by allowing wells to flow uncontrolled for many years.

Objective

Conserve water in the flowing artesian aquifers.

Approach

Reduce flows by rehabilitating wells or plugging unused wells and wells that cannot be economically repaired. Monitor project success by measuring aquifer pressures.

Progress during the 1999–2001 Biennium

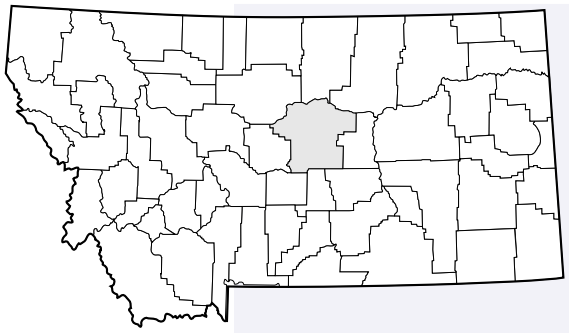
A total of 84 wells were assessed and the project funded repairs on 52 of these. Millions of gallons of water were conserved as evidenced in pressure increases in the aquifers. The enclosed hydrograph illustrates the water-level response in the Eagle aquifer in an area of repaired wells.

Plans for the 2001–2003 Biennium

Project is completed and report has been submitted for final review. Masters Thesis completed by Mike Brayton.

Information Products

Proposed MBMG open-file report or report of investigation pending final review.



Project Title: Rehabilitating Flowing Wells in the Big Spring Watershed, Fergus County

Location: Fergus County

Period of Project: July 1999–July 2002

Project Leader: Jon Reiten

Project Staff: Fergus CD Staff, Teresa Donato

Funding Sources: Private landowners, Fergus County Conservation District, Montana Department of Natural Resources and Conservation, EPA 319 nonpoint source pollution grant, Montana Bureau of Mines and Geology

Problem

Landowners have noticed a decline in aquifer pressure and productivity. This decline is caused by allowing wells to flow uncontrolled for many years.

Objective

Document major aquifers and conserve water in the flowing artesian aquifers.

Approach

Reduce flows by rehabilitating wells or plugging unused wells and wells that cannot be economically repaired. Monitor project success by measuring aquifer pressures.

Progress during the 1999–2001 Biennium

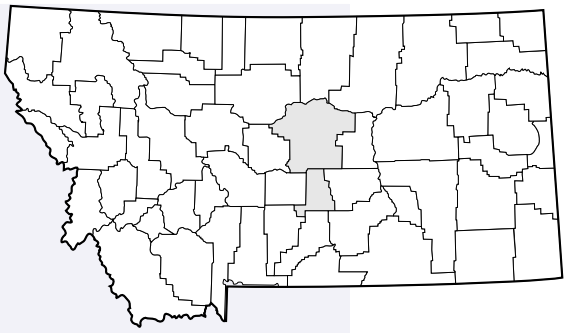
Collect data on major aquifers, compile the data, develop aquifer and ground water flow maps.

Plans for the 2001–2003 Biennium

Assess and repair flowing wells in the watershed.

Information Products

Proposed MBMG open-file report or report of investigation.



Project Title: City of Roundup Water Supply Study

Location: Little Snowy Mountains and South Flank of Big Snowy Mountains, Central Montana

Period of Project: Began September 1999; expected completion June 2000

Project Leaders: John Wheaton, Karen Porter

Funding Source: City of Roundup, Montana Bureau of Mines and Geology

Issue

The City of Roundup is seeking an alternative to its existing water supply. One opportunity may be found in a known bedrock aquifer exposed in the Big and Little Snowy Mountains. It is necessary to understand the geologic setting and resulting ground-water flow regime of the region. From that knowledge we will be able to discuss the feasibility of acquiring an adequate quantity and quality of water for a municipal water supply.

Objectives

MBMG is conducting the necessary geologic and hydrologic studies to provide the basis for evaluating the feasibility of the ground-water resources.

Approach

Our approach to this investigation is to (1) evaluate the existing published and unpublished geologic and hydrologic information for the region; (2) determine and conduct needed additional field work; and (3) develop a regional understanding of the most likely flow paths, residence time, and resulting water quality and quantity of the aquifer. Particular emphasis is being placed on the geologic structure in the region; recognized folds and faults, and others not recognized or having no surface expression, will play a major role in the flow of ground water in the area. Additionally important is the availability of adequate recharge area for the aquifer.

Progress during the 1999–2001 Biennium

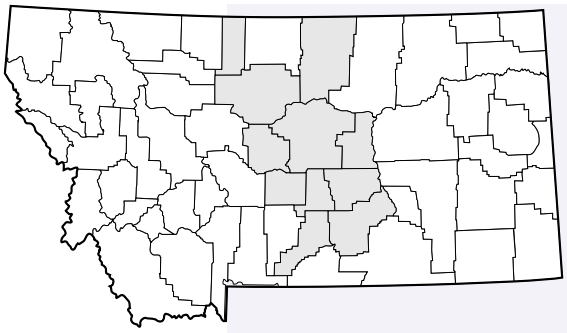
This is a new project and planned for completion during this biennium. We have conducted the field work, using MBMG's published geologic maps of the area and other published and unpublished data. Ground-water flow models for the region have been discussed, and a report has been prepared on the feasibility of acquiring adequate water supplies for the City of Roundup.

Information Products

The final report is issued as MBMG Open File Report 401B, entitled, Hydrogeological Assessment of the Roundup, Montana, Public Water Supply for Ground Water under the Direct Influence of Surface Water.

Project Title: Ground-Water Sources under the Direct Influence of Surface Water

Location: Public Water Supplies in Beaverhead, Carbon, Cascade, Choteau, Flathead, Granite, Lincoln, Mineral, Park, Pondera, Sanders, and Teton Counties



Period of Project: April 1995–June 2000

Project Leaders: Ted Duaime, Alan English, and Rich Marvin

Project Staff: James Madison, Pete Norbeck, James Rose, Jon Reiten, John Wheaton

Funding Sources: Montana Department of Environmental Quality

Issue

Public water supplies that are presently classified as having ground-water sources may have a surface-water component and thus may require treatment with chlorination and/or filtration systems to meet drinking-water standards.

Objective

To identify public-water supplies directly under the influence of surface water.

Approach

1. Complete preliminary assessments on public-water supplies that use springs, infiltration galleries, and/or shallow wells.

2. Prepare a hydrogeological assessment report for sources that are found to be at risk of being under the influence of surface water based on the preliminary assessment.

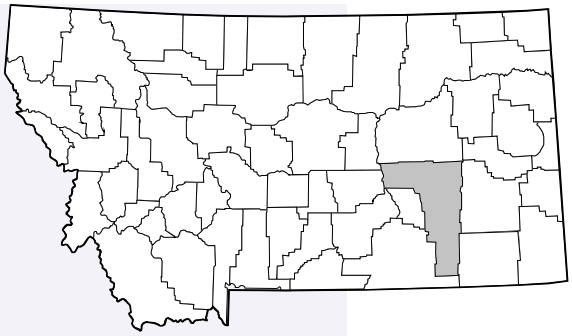
3. Submit conclusions to DEQ as to whether the source is under the direct influence of surface water and provide recommendations for ways to protect and/or improve the source.

Progress during the 1999–2001 Biennium

Hydrogeological assessments were completed for the following public-water supplies: Alberton, Aldrich Spring, Alhambra, Apgar, Basin, Bear Creek, Bridger Bowl, Carter-Choteau, Cascade Colony, Chico Hot Springs, Clyde Park, Cooke City, Coram, Country Estates Subdivision near Kalispell, Evergreen Health and Rehabilitation Center in Clancy, Eureka, Fromberg, Gardiner, Hay Coulee Water Users Association (WUA) in Inverness, Hidden Lake, Hill County, Ingomar, Kevin, King Colony, Lima, Miller Colony, Mount Silver Springs, Inc. in Phillipsburg, Oilmont, Plains, Rapelje, Roundup, Ryan Dam near Great Falls, South Chester, Silver Gate, Stockett, Surprise Creek, Two Buttes WUA at Sun River, and Woods Bay.

Information Products

Open-file reports on the hydrogeology of the water supplies listed above.



Project Title: Hydrologic Assessment of West Fork Armells Creek, Rosebud County, Montana

Location: Near Colstrip, Montana

Period of Project: November 1998–September 2000

Project Leader: John Wheaton

Project Staff: John Olson, field technicians, and students

Funding Source: Department of Environmental Quality through the 319 program

Issue

The Montana Section 303(d) list shows a variety of nonpoint source (NPS) impacts to West Forks Armells Creek. The type, location and source of impacts likely relate to agriculture and natural sources. The purpose of this project is to determine what reaches, if any, require TMDL development; and to identify impacts and causes which can then be specified for NPS abatement.

Objectives

The goals of the project are to document current conditions and any apparent changes that have occurred along the stream reaches. Data collected during this project will be compared with data collection efforts from the early to mid-1970s. Influence of ground water on the surface-water resources will be a strong component of the project. In particular, potential impacts from coal-mining spoils aquifer discharge to West Fork Armells Creek will be investigated. The Rosebud Coal seam is mined within the Armells Creek watershed, but naturally crops out between the mining areas and West Fork Armells Creek. Due to the apparent lack of hydrologic continuity, mining-related impacts to the creek are not expected but will be investigated to insure appropriateness of TMDL's.

Approach

Project goals will be met by collecting water-quality samples at sites along the stream and at adjacent wells. Relationships between stream stage and water levels in wells will be determined. Sites will be chosen based on landowner access, and availability of nearby shallow wells. Geologic cross sections will be drawn, including ground-water flow directions, to identify potential for mining-related impacts.

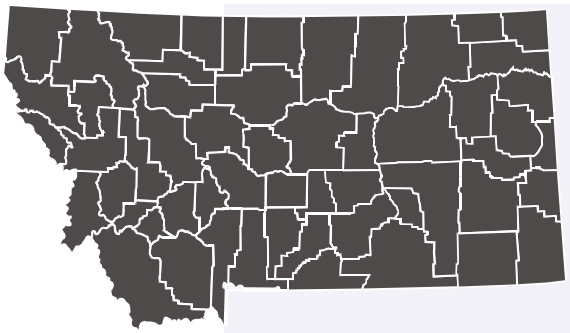
Based on spatial and temporal variations in stream conditions, both positive and negative impacts can be identified. Any necessary TMDL constraints can be designed based on the existing conditions and land-use patterns.

Progress during the 1999–2001 Biennium

Streamflow, water quality and ground-water levels have been measured. Existing data have been compiled.

Plans for the 2001–2003 Biennium

Continue streamflow and water-quality monitoring and import remainder of existing data into watershed data base. MBMG will write reports and lead field trips along with Rosebud Conservation District.



Project Title: Abandoned and Inactive Mines Inventory and Preliminary Assessment

Location: U.S. Forest Service Lands and U.S. Bureau of Land Management Lands; State Wide

Period of Project: USFS: May 1992–Present

BLM: October 1993–Present

Project Leader: John Metesh

Project Staff: Ted Duaime, Jeffrey Lonn, Richard Marvin, James Madison, Phyllis Hargrave, Mike Kerschen

Funding Sources: U.S. Forest Service (USFS), U.S. Bureau of Land Management (BLM)

Problem

To inventory and conduct preliminary screening and assessment of all abandoned and inactive mines on USFS and BLM lands in Montana.

Objectives

To collect accurate location, water, and solid chemistry data; to conduct a preliminary screening of sites on USFS and BLM lands; and to compile existing and new data in a data base.

Approach

1. Use existing information from other data bases, the literature, and MBMG files to identify sites for investigation.

2. Conduct a field inventory and preliminary screening of sites on USFS and BLM lands.

3. Conduct a preliminary assessment, including sampling, of all sites identified in the preliminary screening as having a potential for health or environmental impacts.

4. Compile all information into a data base.

5. Prepare reports for each drainage in each forest (USFS) and resource area (BLM).

Progress during the 1999–2001 Biennium

All inventories, screening, and site assessments were completed for the Deerlodge, Helena, Beaverhead, Lewis & Clark, and Kootenai national forests, as well as BLM lands state wide. The inventory of mines and mills in the Gallatin and Custer forests is underway. Final reports were prepared for the Deerlodge National Forest (5 volumes), the Helena National Forest (2 volumes), the Beaverhead Forest (1 volume), the Lewis & Clark Forest (1 draft volume), and the Kootenai Forest (1 draft volume). Draft reports for the Gallatin and Custer forests are in progress.

Plans for the 2001–2003 Biennium

The inventory of all national forests, along with final reports, is scheduled for completion in 2001. Many of the sites identified in the inventory are scheduled for reclamation. The MBMG and Montana Tech have begun work on reclamation and post-reclamation monitoring.

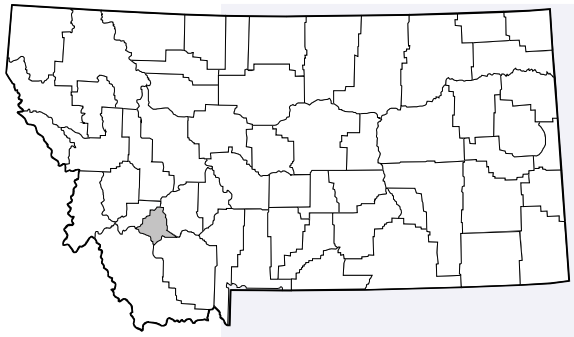
Information Products

Metesh, J.J., Lonn, Marvin, R.K, Hargrave, P.A., and Madison, J.P., 1998, Abandoned-Inactive Mines in the Helena National Forest, Volume I: Upper Missouri River Drainage, May 1998, MBMG-352, 195 p.

Hargrave, P.A., Bowler, T.P., Lonn, J., Madison, J.P, Metesh, J.J., and, Wintergerst, R., 1998, Abandoned-Inactive Mines in the Helena National Forest, Volume II: Blackfoot and Little Blackfoot River Drainages, February, 1998, MBMG-368, 181 p.

Marvin, R.K., Hargrave, P.A., Lonn, J., Abdo G.N., Metesh, J.J., and Bump, K., 1998, Abandoned-Inactive Mines in the Southern Beaverhead–Deerlodge National Forest, September 1998, MBMG-379, 322 p.

Environmental Assessment in Butte Area



Project Title: Butte Mine Flooding Technical Assistance

Location: Silver Bow County

Period of Project: Ongoing since 1987

Project Leader: Ted Duaime

Project Staff: John Metesh, James Rose, Mike Kerschen, Curt Dunstan, Marvin Miller

Funding Source: Montana Department of Environmental Quality

Problem

Rising ground-water levels in and adjacent to the abandoned underground mines and the Berkeley Pit as a result of the 1982 suspension of mining. The rising ground water is acidic and highly contaminated with trace metals.

Objective

Provide assistance to the state of Montana (Department of Environmental Quality) and U.S. Environmental Protection Agency (EPA) in overseeing the collection of water-level and water-quality data, collect additional data, and provide results of monitoring and sampling activities to the general public. Review and evaluate data, identify changes and trends, and to provide an annual update to the state, EPA, and the public.

Approach

Maintain a network (over 100 sites) of monitoring wells and mine shafts throughout the Butte basin. Collect weekly and monthly water-level data and periodic water-quality data. Assist ARCO contractors with the selection of additional monitoring-well locations and provide oversite assistance during installation of new or replacement monitoring sites. Compile and evaluate newly collected data for distribution to interested parties, *e.g.*, local government and citizens, and prepare an annual update on water levels, water-quality conditions, and the effects, if any, ground water and/or surface water, in the area.

Progress during the 1999–2001 Biennium

Assisted with the installation of one replacement bedrock monitoring well and the abandonment of one well. Evaluated the integrity of nine bedrock monitoring wells with the intent to identify potential problems with well corrosion, etc., at an earlier date. This might lead to refurbishment of wells instead of complete abandonment and then replacement with a new well. Made modifications in the upper 300 feet of an abandoned mine shaft to aid in data collection. Incorporated data collected during fiscal year 1999–2000 into existing data bases and provided to interested parties on a monthly basis. Collected and analyzed water-quality samples from selected wells, surface waters, the Berkeley Pit, and mine shafts. Data were reviewed for changes in trends from previous results and added to the data base. Continued an evaluation on the flow

(quantity) and quality of ground water entering the Berkeley Pit. Prepared separate reports evaluating trends in water levels and water quality since flooding began in 1982.

Plans for the 2001–2003 Biennium

Continue to review and analyze collected data and prepare annual updates on water levels and water-quality conditions. Continue water-level monitoring and water-quality sampling activities. Perform annual evaluation of bedrock well integrity by downhole camera methods.

Participate in Butte Silver Bow education program for the dissemination of information to the public. Collect bulk water samples from the Berkeley Pit for technology evaluations. New data will be entered into the existing data bases.

Information Products

Two MBMG open-file reports, one report on water levels and one report on water-quality trends over the previous year. Interim reports (monthly) are submitted to DEQ.

Project Title: Biosulphide Copper and Zinc Recovery and Water Treatment

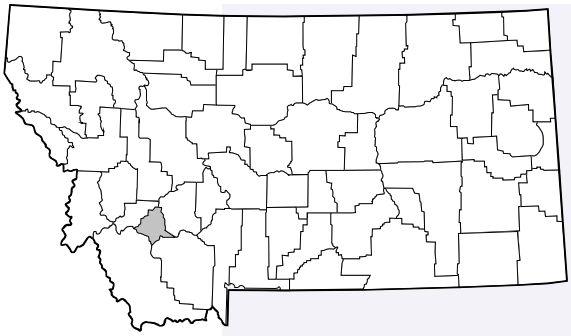
Location: Silver Bow County

Period of Project: 1999–2000

Project Leader: James Madison

Project Staff: Brian Beam, Victor Eleeas

Funding Source: Biomet Mining Corporation



Problem

The Berkeley Pit Lake contains about 30-billion gallons of acidic, metal-laden water containing about 40-million pounds of dissolved copper and 150-million pounds of dissolved zinc. Recovering the copper and zinc could offset the costs associated with EPA mandated water treatment in the future.

Objectives

Provide assistance to Biomet Mining Corporation in the development of project work plans, pilot-plant operation, and maintenance. Assist with the collection of solid and water samples from process stages for chemical analyses.

Approach

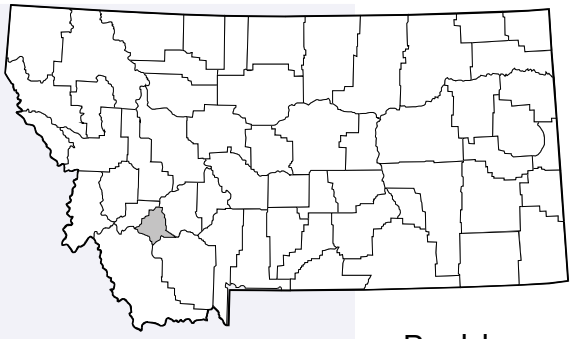
Construct a pilot plant—using off-the-shelf components—that consist of a bioreactor capable of providing hydrogen sulfide gas to a five-gpm chemical circuit where dissolved copper and zinc in Berkeley Pit Lake water are precipitated as sulfides and selectively recovered. Insure that critical measurements such as chemical addition rates, and flow rates are measured accurately to provide good numbers for engineering scale-up analysis.

Progress during the 1999–2001 Biennium

The bioreactor and chemical circuit were operated, and produced several hundred pounds of copper sulfide and zinc sulfide. Data were collected for the engineering scale-up analysis.

Information Products

A final report addressing the various subtasks will be submitted to Biomet Mining Corporation.



Project Title: Modeling the Effects of Water Level Rise on the Alluvial Aquifer Associated with the Berkeley Pit

Location: Butte, Montana

Period of Project: May 2000–April 2001

Project Leader: John Metesh

Funding Sources: Montana Tech Mine Waste Technical Pilot Program, EPA/DOE

Problem

The water level in the Berkeley Pit has risen a little more than one foot per month for the last several years. There are several sources of ground water and a range of ground-water qualities entering the pit: a) contaminated ground water from the underground workings in the bedrock aquifer west of the pit; b) uncontaminated ground water from the bedrock aquifer east and southeast of the pit; and c) contaminated alluvial ground water from east and south of the pit. At a water depth of 850 feet, the rising water in the pit is presently not in contact with the alluvial aquifer, but rather, seepage faces have formed along the rim of the pit near the bedrock-alluvium contact. The rising water level in the pit will reach a depth of about 1150 feet (100 feet above the bedrock-alluvial contact) before controls will be implemented. There presently exists a ground-water divide roughly coincident with Continental Drive between the Berkeley Pit and the Butte valley. Ground water and surface water north of the divide flow into the pit while ground water and surface water south of the divide flow into upper Silver Bow Creek. As the pit water level rises above the bedrock-alluvium contact, the ground-water gradient toward the pit will decrease, possibly shifting the ground-water divide south of the pit and, thereby, diverting a portion of the ground water now flowing into the pit to the Butte valley. This would manifest as a general increase in water levels through out the residential area south of the pit and an increase in flow in the upper Silver Bow Creek.

Objectives

This project will evaluate the effect of water level rise in the Berkeley Pit and bedrock aquifer on the surrounding alluvial aquifer.

Approach

A multilayer, three-dimensional ground-water flow model will be used to simulate effect of the pit water level rise.

Progress during the 1999–2001 Biennium

Geologic and hydrogeologic data have been compiled, and initial simulations of several hydrologic components of the area have been successful.

Plans for the 2001–2003 Biennium

The flow model and final report will be completed in the spring of 2001.

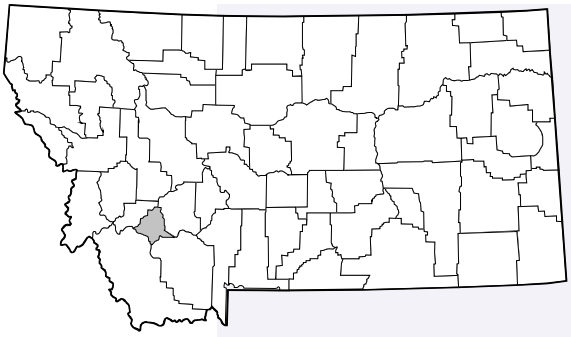
Project Title: Natural Resource Damage Assessment-Butte Area and Montana Pole Treatment Site

Location: Butte, Montana

Period of Project: Ongoing since May 1991

Project Leader: Ted Duaime, John Metesh, and James Madison

Funding Source: Montana Department of Justice



Problem

There have been multiple and continuous releases of hazardous substances from mining, milling, and other industrial sources to the upper Clark Fork River basin. The resources affected by these releases include air, surface water, ground water, soils, benthic macroinvertebrates, fish, wildlife, and wildlife habitat.

Objective

To provide the state with the best available information pertaining to ground-water flow and quality related to the Butte Area Superfund site and the Montana Pole Treatment Plant Superfund site.

Approach

The Bureau participated in the assessment of injury to ground water in the Butte area related to mining and at the Montana Pole Treatment Plant in Butte. The Bureau further participated in preparation of restoration alternatives for the Butte area.

Progress during the 1999–2001 Biennium

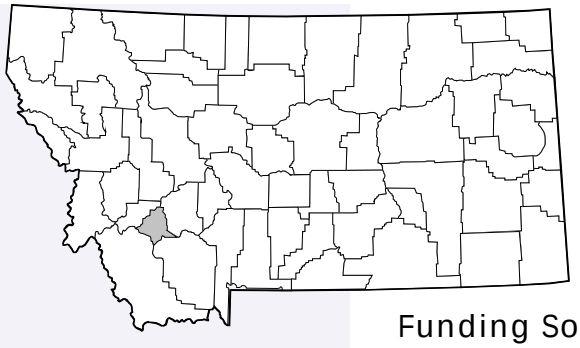
Findings indicated that approximately 112 billion gallons of ground water in an area of nearly nine square miles of the Butte alluvial and bedrock aquifers have been contaminated by mining and mining-related activities. Approximately 330 million gallons of ground water in an area of about 0.07 square miles have been injured by contamination by pentachlorophenol (PCP), a wood preservative, at the Montana Pole Treatment Plant site. Several portions of the lawsuit, including the Montana Pole Treatment Plant site and the Butte hill aquifer, have been settled.

Plans for the 2001–2003 Biennium

The Bureau will be collecting additional data on the Butte Area, Silver Bow Creek portion of the claim. This includes an evaluation of the effectiveness of recent reclamation efforts at the Colorado Tailings site and additional information on the nature and extent of contamination of upper Silver Bow Creek.

Information Products

None at this time.



Project Title: Montana Pole Treatment Plant, Bioremediation of Soils, Environmental Monitoring and Operation of Water Treatment Plant

Location: Silver Bow County

Period of Project: Ongoing since 1995

Project Leaders: Ted Duaime, Tom Bowler

Project Staff: Jamie Veis, Curt Dunstan, James Rose

Funding Source: Montana Department of Environmental Quality

Problem

The Montana Pole treatment plant superfund site is the location of a former wood-treating facility that operated from 1946 to 1985. Contamination of soils, ground water, and Silver Bow Creek has occurred as a result of discharges of solutions used in the treating process. Primary chemicals of concern are diesel fuel and pentachlorophenol (PCP). The State of Montana, U.S. Environmental Protection Agency and the Montana Department of Justice have reached a settlement with the responsible parties. Remedial actions on the north portion of the site have been completed, and work is underway on the south portion of the site. Contaminated soils removed during north side cleanup have been treated to concentrations well below specified levels and have been returned to the north side and covered. Monitoring of contamination levels in air, soil, and water are required to ensure that no additional release of contaminates occurs that might affect adjacent residential homes, Silver Bow Creek, or uncontaminated ground water.

Objective

Assist the State of Montana in the development and setup of an environmental monitoring network to ensure there is no off-site migration, or release, of site contaminates. Operate site water-treatment plant, and perform monitoring and sampling activities to establish contaminate levels. Provide all environmental monitoring during site cleanup and construction activities.

Approach

Develop and implement a monitoring plan for the organization and implementation of this remedial action plan.

Monitor particulate levels from site construction and demolition activities as well as PCP concentrations. Collect monthly samples of removed soils, residual soil, surface water (Silver Bow Creek), and ground water to test PCP concentrations; collect samples as necessary to aid.

Project Title: Streambed Sediment Sampling, SSTOU-Subarea 1 and Stream Sampling, LAO/ SSTOU-Subarea 1

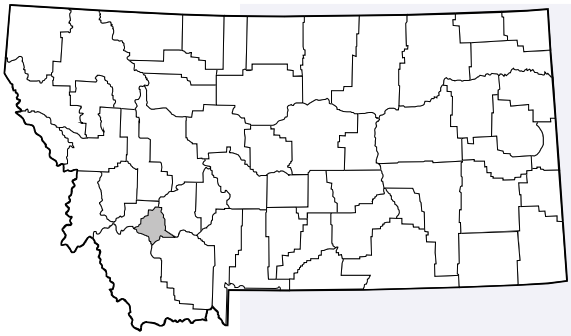
Location: Silver Bow County

Period of Project: Began Spring 2000

Project Leader: Ted Duaime

Project Staff: Peter Norbeck, Curt Dunstan

Funding Source: Montana Department of Environmental Quality



Problem

Potential recontamination of the reconstructed stream channel in the Stream Side Tailings Operable Unit-subarea 1.

Objective

Provide assistance to the State of Montana and the U.S. Environmental Protection Agency (EPA) in the collection of streambed sediment and water samples, compilation and analysis of data, and monthly reporting of analytical results. Data will be evaluated to identify changes and trends.

Approach

Streambed sediment samples will be collected periodically from three sites at the upstream end of the reconstructed stream channel. Samples will be sieved to determine grain-size distribution and splits from three grain-size fractions (clay, silt, and sand) will be analyzed for arsenic, cadmium, copper, iron, manganese, lead, and zinc.

Stream samples will be collected from up to six sites on Silver Bow Creek and its tributaries up to three times: runoff event, storm event, and non-storm event. Samples will be analyzed for total suspended sediment, sulfate, aluminum, arsenic, cadmium, chromium, copper, iron, manganese, lead, mercury, and zinc. Streamflow and channel cross sections (relative to a permanent reference point) will be measured when possible.

Data will be entered into a data base for reporting and to facilitate entry into the Ground-Water Information Center data base.

Progress during the 1999–2001 Biennium

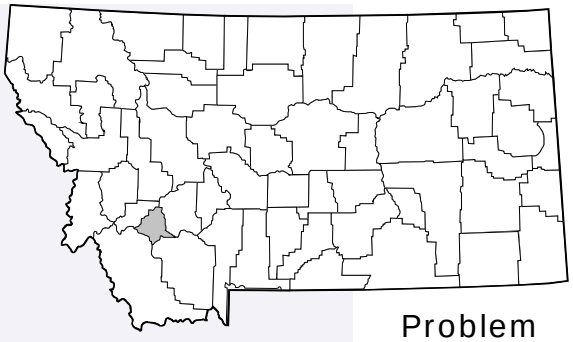
Initial samples have been collected along with stream flows and channel cross sections and a data base established.

Plans for the 2001–2003 Biennium

Continue to collect and analyze data and prepare periodic updates on water quality and streambed conditions. New data will be entered into the existing data bases. A final report addressing the various subtasks will be completed.

Information Products

Interim reports (monthly) are submitted to DEQ. Two final reports, one report on streambed sampling and one report on stream sampling and streamflow will be produced.



Project Title: Ground-Water Monitoring and Data Collection, SSTOU-Subarea 2

Location: Silver Bow County

Period of Project: Began April 1999

Project Leader: Peter Norbeck

Funding Source: Montana Department of Environmental Quality

Problem

Tailings deposited over much of the flood plain of Silver Bow Creek by flooding early in the century are largely devoid of vegetation and are a source of contamination for ground and surface water. The State of Montana, U.S. Environmental Protection Agency and the Montana Department of Justice have reached a settlement with the responsible parties and are undertaking remedial actions on subarea 1. Monitoring of ground-water levels and surface flow in Silver Bow Creek is required for remedial design efforts for subarea 2.

Objective

Provide assistance to the State of Montana in the collection of ground- and surface-water data, and generate water table and depth-to-water maps. Review and evaluate data, identify changes and trends, and provide quarterly updates to the state and EPA. The data will be used in remedial design efforts for subarea 2.

Approach

Develop and maintain a network (100 sites) of monitoring wells and surface-water sites along Silver Bow Creek. Implement a monitoring plan for the collection, organization, and dissemination of data. Water levels and streamflow data are collected monthly throughout the year and weekly from selected wells during the growing season. Data are evaluated and compiled monthly for DEQ and quarterly for EPA.

Progress during the 1999–2001 Biennium

Existing monitoring wells were identified and located, 50 new monitoring wells were drilled, and nine new surface water sites were established. In addition, five surface-water sites from previous studies were located and reactivated.

Plans for the 2001–2003 Biennium

Continue to collect and analyze data and prepare periodic updates on water level trends and stream flows. New data will be entered into the existing data bases. A final report addressing the various subtasks will be completed.

Information Products

Interim reports (monthly) and data compilations, with results of environmental monitoring and sampling, will be submitted to the DEQ. Reports are being submitted quarterly to the EPA. An electronic data base has been constructed for storage of environmental data and to aid in the transfer of data to the Ground-Water Information Center data base. A final report including water table and depth-to-water maps will be prepared for high and low water-level conditions.

Project Title: Butte Priority Soils–Lower Area One Technical Assistance

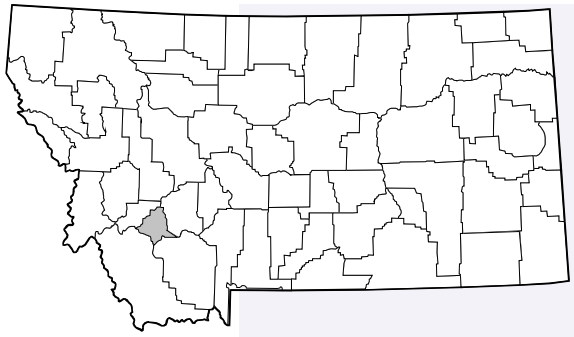
Location: Silver Bow County

Period of Project: Ongoing since 1991

Project Leader: James Madison

Project Staff: Ted Duaime, Mike Kerschen, John Metesh, James Rose

Funding Source: Montana Department of Environmental Quality



Problem

Contaminated soils and mine waste from more than 100 years of mining and mining-related activities are distributed in and around the community. These wastes are potential sources of surface-water and ground-water contamination.

Objectives

Provide assistance to the State of Montana in the development of project work plans, oversee the collection of water-level and water-quality data, collect additional data, and provide results of monitoring and sampling activities. Assist with the collection of storm-water runoff samples from drainages on the Butte Hill for characterization of dissolved and suspended metal loads to Silver Bow and Blacktail creeks.

Approach

Provide monthly water-level data and periodic water-quality data collected from a MBMG network of over 50 monitoring wells throughout the study area and collect monthly water-level data and periodic water-quality data. Provide assistance to Atlantic Richfield Company contractors with the selection of monitoring well locations and provide oversite assistance during installation monitoring well installation. Provide guidance and review of work plans, sampling plans, and investigative reports for the state.

Progress during the 1999–2001 Biennium

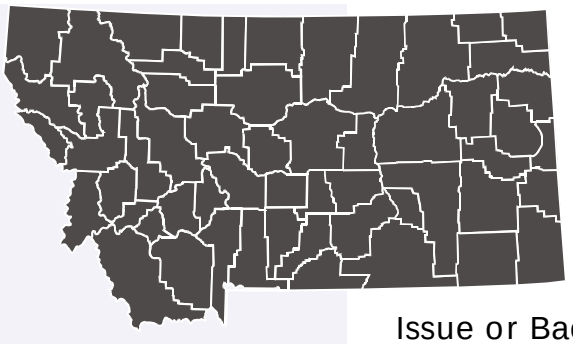
Monitoring of water levels in selected wells was continued on a monthly schedule. The MBMG provided review and comments on technical documents per DEQ request and participated on several projects: Butte storm-water investigation, Butte alluvial aquifer investigation, lower area one operable unit tailings removal, survey of reclaimed areas, and survey of unreclaimed areas.

Plans for the 2001–2003 Biennium

Continue water-level monitoring and water-quality sampling activities. Assist with collection of storm-water runoff samples. Continue to provide assistance to the state in the form of document review and field investigations.

Information Products

Interim reports (monthly) and a final report addressing the various subtasks will be submitted to DEQ. New data will be entered into the existing data bases.



Project Title: Adit Discharge Control
Location: State Wide
Period of Project: March 1998–October 2001
Project Leader: John Metesh
Project Staff: Phyllis Hargrave and Mike Kerschen
Funding Source: USFS-Missoula Technology Development Center

Issue or Background

In its ongoing work with the USFS-Region 1, the Montana Bureau of Mines and Geology has screened about 3100 abandoned-inactive mines on USFS- and BLM-administered lands in Montana. Of these, about 220 sites on USFS-administered land have one or more adits that discharge water at least part of the year. Poor-quality adit discharges can have deleterious effects on aquatic life, fisheries, and riparian areas downstream. Adit discharges, regardless of the water quality, contribute greatly to the leaching of metals from waste-rock dumps that are commonly near the adit. The cumulative metals loading from adit discharges can be detrimental in some of the smaller drainages.

In March of 1997, the Forest Service Missoula Technology and Development Center and the Montana Bureau of Mines and Geology initiated a program to summarize current methods for reducing or eliminating mine adit discharge and evaluate their application to specific conditions.

Objective

The U.S. Forest Service wishes to identify current and available technology for reducing and/or preventing acid mine drainage, and identify and prioritize abandoned and inactive mine sites on or effecting lands administered by the Forest Service at which to use the technology. The objective is to develop a classification of mine types and applicable methods.

Approach

The current literature regarding ground-water recharge control, acid mine drainage processes, and remediation techniques were reviewed and summarized. Also, there are several ongoing investigations by the MBMG and others regarding ground-water flow into underground openings. Information from these studies will enhance the development of discharge control methods.

Progress during the 1999–2001 Biennium

A review of current technologies was completed and published by the U.S. Forest Service. A summary report of the chemical physical characteristics of adit discharges in Montana was completed; publication is pending. Two sites, the Elkhorn mine and Charter Oak mine, were selected for detailed monitoring of the flow and field chemistry of adit discharges.

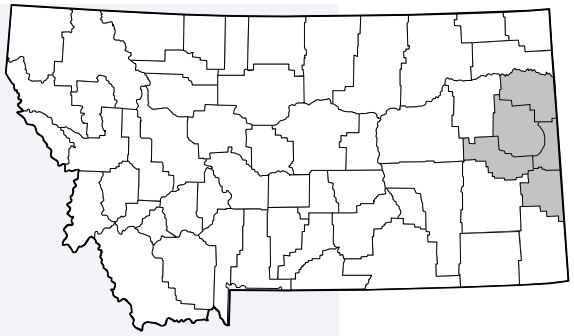
Plans for the 2001–2003 Biennium

Work will continue on a detailed investigation of geology, geochemistry, and soils associated with the adit discharges at the two sites. The intent is to develop a plan for a permanent reduction of the adit discharge at both sites.

Information Products

Metesh, J.J., Jarrell, T., Oravetz, S., 1998, Treating Acid Mine Drainage from Abandoned Mines in Remote Areas, Tech. Rep. 9871-2821-MTDC, Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology Development Center, 22 p.

Hargrave, P.A. and Metesh, J.J., Adit Discharges in Montana, 18 p., accepted for publication by U.S. Department of Agriculture, Forest Service, Missoula Technology Development Center.



Project Title: Acid-Mine Drainage Prevention, Control, and Treatment Technology Development for the Stockett/Sand Coulee Area

Location: Stockett, Montana

Period of Project: November 1993–March 2000

Project Leader: John Wheaton

Project Staff: Wayne Van Voast, Terry Brown (Western Research Institute), student assistants

Funding Source: Department of Natural Resources and Conservation-RIT program

Issue

This project was developed to assist the State of Montana with development of a methodology to ameliorate acid mine drainage associated with abandoned coal mines located in the Stockett/Sand Coulee area.

Objectives

To thoroughly define the ground-water flow system, to identify the types and locations of reactions that are creating acidity, and to identify and evaluate prevention techniques that are specific to this setting.

Approach

The first step in controlling the highly acidic water discharging from abandoned coal mines in the Stockett/Sand Coulee area is to develop a thorough understanding of the hydrogeologic setting and chemical reactions that are causing the acid formation.

Progress during the 1999–2001 Biennium

Field work and data collection were completed, and the ground-water system defined based on data collected. The primary recharge to the mine voids is from direct infiltration of precipitation in wheat fields overlying the mined area. Additional recharge may occur where discharge from shallow springs flows across coal outcrop areas and areas where mine-subsidence fractures may reach land surface. Control of acid mine drainage in this area can best be accomplished by reducing recharge through coordinated cropping practices and by sealing surface drainages to reduce leakage.

Plans for the 2001–2003 Biennium

The project has been completed.

Information Products

Wheaton, John R., and Brown, Terry, (in review). Acid mine drainage at the Number 6 mine near Stockett, Montana. Montana Bureau of Mines and Geology Open-File Report.

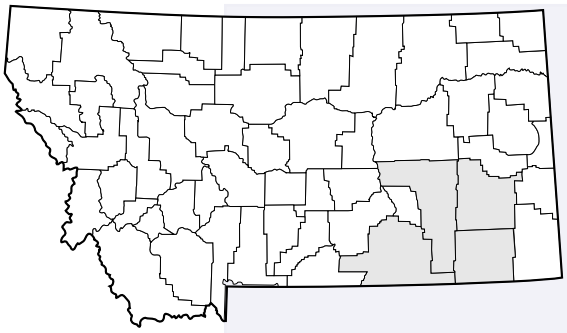
Project Title: Mitigation of Hydrologic Impacts of Coal-Bed Methane Development

Location: Southeastern Montana

Period of Project: 1999–Present

Project Leader: John Wheaton

Funding Sources: Montana Water Resources Center (MSU), U.S. Bureau of Land Management



Issue

Coal-bed methane development in Montana challenges industry and regulators to provide proper safeguards for water resources. Methane production requires pumping and releasing large volumes of ground water. This method of production will impact water availability over large areas, and will impact water quality in streams that are used for irrigation. The degree of impacts will be determined largely by the number of wells being pumped, and the rates of discharge.

Production is accomplished by pumping ground water from the coal beds to decrease hydrostatic pressure in the aquifer. With sufficiently decreased pressures, methane gas desorbs from the coal and is discharged with the well water. Thus far production is established and expanding in New Mexico, Colorado, and Wyoming. Development in Montana began in 1999 with 127 wells near Decker producing 8 million cubic feet of methane gas per day, and 3 million gallons of water per day. The gas is a high BTU, clean-burning fuel. The water is usable for human and livestock consumption but unfit for irrigation.

Objectives

Many additional wells are expected, possibly exceeding the thousands already producing in Wyoming. The objectives are to predict and mitigate the areas of ground-water depletion, and to manage the discharge of high-sodium water to safeguard irrigation uses of the Tongue River.

Approach

The Montana Bureau of Mines and Geology has begun research on several aspects of coal-bed methane development. A GIS coverage of gas wells, leases, coal depths and outcrops, watercourses, springs and water wells is under preparation to give planners and regulators a perspective of development as it proceeds. The Bureau is assisting the U.S. BLM in the preparation of an Environmental Assessment (EA) of the first 250 wells in Montana, and is conducting a comprehensive literature search for the BLM on technical aspects of coal-bed methane and topics associated with development. Bureau members serve on a Technical Advisory Committee on ground-water problems related to development, and on several multi-agency (state, federal, tribal) committees to coordinate agency responsibilities. First projections of discharge water quantity and quality have been made, and impacts on irrigation have been predicted for hypothetical levels of development. The Bureau's long-established coal-hydrology monitoring program has been maintained and expanded to provide additional data. As methane production in Montana increases, the

Bureau, in cooperation with other agencies, will document and predict impacts and will offer mitigation measures where possible.

Progress during the 1999–2001 Biennium

The program was initiated during this biennium and the above described work was accomplished.

Project Title: Coal Lands Hydrogeology

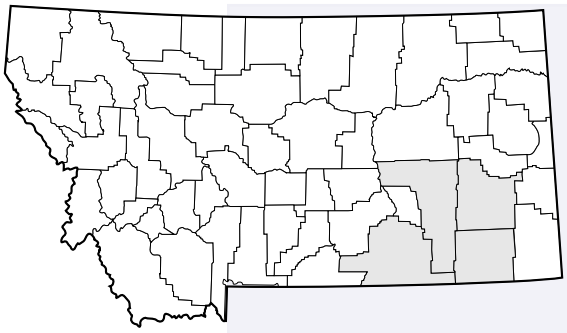
Location: Southeastern Montana

Period of Project: Ongoing since the early 1970s

Project Leader: Wayne Van Voast

Project Staff: John Wheaton, Joe Lalley

Funding Sources: U.S. Bureau of Land Management, Montana Bureau of Mines and Geology



Problem

Energy is not the only resource provided by coal beds in southeastern Montana. In this semi-arid climate, inhabitants almost totally depend on ground water for stock and domestic supplies, and in many places ground water is obtained from coal beds that will be removed by mining. Mine-spoil aquifers may be of limited value as a water resource and may impact water quality in downgradient aquifers.

To ensure rational and efficient coal resource decision making by mining companies and regulators, the impacts of mining on ground water must be well documented and thoroughly understood. Because mining and associated impacts have long durations, the study of the associated hydrology needs to be a long-term commitment.

Objectives

Document hydrologic impacts associated with coal-strip mining. Develop models that can be used to predict those impacts using hydrogeologic baseline data and mine plans; and use the information to plan, mine, and reclaim for minimum hydrologic impact.

Approach

1. Measure water levels and collect water samples at over 200 wells in and outside of mine areas. Wells should reflect mining-impacted aquifers as well as aquifers that are not impacted but can provide background data and natural seasonal variations.

2. Maintain the data in computer data bases.

3. Review the data, analyzing temporal and spatial trends.

4. Interpret the information and disseminate it to regulators and industry.

Progress during the 1999–2001 Biennium

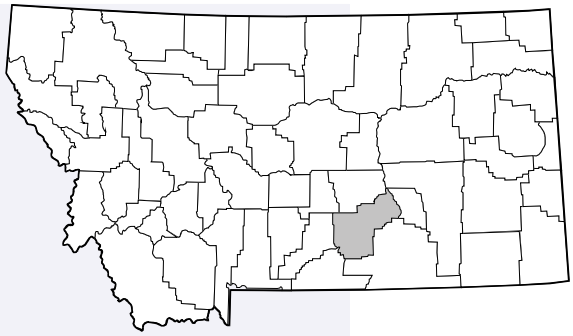
Continued data collection at mining areas near Colstrip and Decker. Reviewed data for mining impacts. Data collected and interpretations of those data were used at numerous presentations, including public meetings and scientific conferences. The value of the data base due to its longevity and continuity has been a point of positive discussion at these meetings.

Plans for the 2001–2003 Biennium

Continue monitoring program, and visit older study sites. Present technical papers at workshops and scientific conferences. Collect water-quality samples and perform aquifer tests, with emphasis on the Decker area.

Information Products

This long-term project has produced many formal publications.



Project Title: Bull Mountains Hydrogeology
Location: North of Billings, Montana
Period of Project: November 1992–March 1999
Project Leader: John Wheaton
Project Staff: Joe Lalley, students
Funding Sources: Montana Coal Board, Lower Musselshell Conservation District, Montana Bureau of Mines and Geology

Issue

The first longwall coal mine in the Fort Union region was planned in the Bull Mountains. In longwall mining, the roof is collapsed as the mine progresses. The rubble zone and mine voids become a post-mining aquifer. Use of this mining method and standard room-and-pillar mining is expected to increase in the future in Montana. Documentation of the hydrogeologic impacts and tools for predicting underground impacts in this region are needed before more mines of this type are proposed. However, in this case, the mine opened for a short time as a room-and-pillar mine, then closed. The planned site study of hydrogeologic impacts became irrelevant.

Objectives

Collect baseline hydrologic data and build data base for long-term monitoring. Build an understanding of the hydrogeologic system that will be used as the baseline, against which to compare mining impacts in the future.

Approach

Conduct well and spring inventories in and near the mining area. Measure water levels and collect water-quality samples at wells and springs around the mine area before mining begins. Establish a baseline or pre-impact description of the hydrologic system based on these data. Continue water-level monitoring during mining to identify impacts and build predictive tools from the comparison of impacted and non-impacted data.

Progress during the 1999–2001 Biennium

Work is progressing on a report that describes the general hydrogeologic systems in the Bull Mountains.

Project Title: Hydrogeologic and Geologic Feasibility of Coal-Mine Pits as Water Impoundments

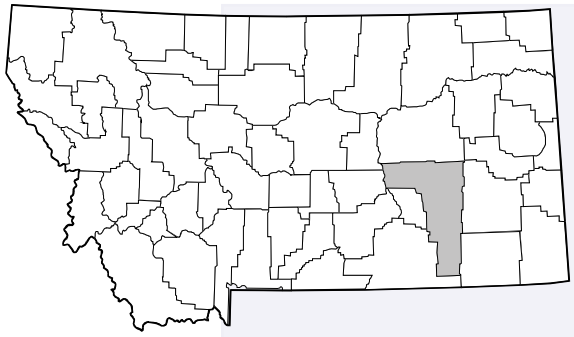
Location: Near Colstrip and Decker, Montana

Period of Project: May 1998–August 2000

Project Leader: John Wheaton

Project Staff: John Olson, Graduate student Warren Phillips, field technicians, and students

Funding Source: Department of Natural Resources and Conservation, RIT program



Issue

Leaving portions of the final pits of coal mines as water impoundments in some situations could benefit mining companies and users of the land after reclamation. The purpose of this project is to build scientific methods and guidelines that can be used to encourage appropriate use of this reclamation technique. Not only would retention of final pits as impoundments provide a more diverse and potentially more useful reclaimed landscape for stock growers and wildlife, but there is also an economic incentive for the companies to pursue this type of reclamation. The reduction in backfilling may represent a significant saving in reclamation costs, thus creating a win-win situation.

Objectives

The project objective is to provide criteria and develop methodologies for assessing the hydrologic and geologic feasibility, as well as the economic desirability, of leaving final mine pits at coal strip mines as water impoundments. Standard reclamation practices for surface coal mines in the west include highwall reduction by backfilling and smoothing mined land to low-angle slopes (approximating the pre-mine topography), and backfilling and grading to eliminate pits created in the mining process. However, pit impoundments could often be used to create beneficial landscapes for stock and wildlife, recreation uses; or beneficial habitat for native bird or animal species.

Approach

The project is designed to produce a thorough understanding of mine-pit impoundments at two sites in southeastern Montana by documenting and interpreting hydrogeologic conditions. Interpretation of data will provide an explanation of why the ponds exist in their current conditions. Required data include bedrock and spoils ground-water surface elevation and fluctuation; aquifer hydraulic conductivities; aquifer storativities; surface-water elevation; precipitation; surface runoff reaching pond; evapotranspiration; ground-water and surface-water quality; elevation of bottom of pond; and geochemistry of sediments and of aquifer material.

As data are analyzed and interpreted, techniques that can be used in future reclamation applications and permits to determine in advance the feasibility of final-pit impoundments will be identified and developed. Hypothetical models will be developed and applied to assess theoretical impoundments.

Progress during the 1999–2001 Biennium

Collection of field data, installation of monitoring wells and other sites, and compilation of new and existing data have been essentially completed during this biennium. Interpretation of those data and analysis of hypothetical mine-pit impoundment sites will also be complete. Final reports and field workshops are planned for summer 2000.

Plans for the 2001–2003 Biennium

This project will be completed prior to the new biennium.

Grants and Contracts

Marvin R. Miller

Assistant Director

To better serve the needs of Montana citizens and to broaden its overall effectiveness, the Montana Bureau of Mines and Geology has continued to expand its grants and contracts program. During the past two years, Bureau professionals in Butte and Billings have been involved in over 70 outside-funded projects cooperating with more than 100 different local, state, federal, and private organizations. These projects, evaluating virtually all aspects of Montana's vast water and mineral resources, are distributed throughout Montana. Brief descriptions of most of these investigations are included in other sections of this report.

For many years, the Montana Bureau of Mines and Geology has worked closely with numerous organizations. With increasing concerns related to conservation and careful utilization of our natural resources and escalating regulatory pressures combined with reduced budgets, it is even more critical to work together. Over the biennium the Bureau collaborated with the following organizations on research projects:

Local organizations/communities (42): Alberton, Bearcreek, Carter, Cascade Colony, Choteau, Clyde Park, Cooke City, Coram, Corvallis, Clancy, Dillon, Divide, Eureka, Fairfield, Florence, Fromberg, Gardiner, Great Falls, Hamilton, Helena, Hidden Lake, Ingomar, Kevin, King Colony, Laurel, Lima, Miller Colony, Missoula, Oilmont, Plains, Rapelje, Roundup, Ryan Dam, Sage Creek Colony, Seeley-Swan, Shepherd, Sidney, Silvergate, Stockett, Turner, Victor, and Woodsbay Conservation districts (18): Beaverhead, Big Horn, Daniels, Deer Lodge Valley, Fergus, Glacier, Granite, Liberty, Little Beaver, Lower Musselshell, Mile High, Petroleum, Rosebud, Sheridan, Stillwater, Teton, Upper Musselshell, and Yellowstone

Other groups (7): Flathead County, Hill County, Lewis & Clark County, Missoula County, Park County, Stillwater County, and Yellowstone County

State agencies and organizations (8): Departments of Agriculture; Environmental Quality; Fish, Wildlife and Parks; Justice; Natural Resources and Conservation; Coal Board, Montana Salinity Control Association, and Montana Water Resources Center

Out-of-state organizations (2): Idaho Geological Survey, and Western Research Institute

Montana University System (6): Montana Tech, Butte; The University of Montana, Missoula; Montana State University, Billings; Montana State University, Bozeman; Montana State University, Northern; and Rocky Mountain College, Billings

Indian reservations (3): Crow Tribe, Northern Cheyenne Tribe, and Confederated Salish-Kootenai Tribes

Federal agencies (14): Department of Agriculture; Forest Service; Natural Resources Conservation Service; Department of Energy; Bureau of Indian Affairs; Bureau of Land Management; Bureau of Reclamation; Fish & Wildlife Service; U.S. Geological Survey; National Park Service; Office of Surface Mining; Environmental

Protection Agency; Federal Emergency Management Agency; International Joint Commission, United States/Canada

Private (6): Aramco Training Services Company, Big Hole River Foundation, Midwest Assistance Program, Montana Rural Water Systems Association, Trout Unlimited (George Grant Chapter), Western Heritage Center

In addition, Bureau professionals actively participate on approximately 50 technical advisory committees, councils, or study groups for the benefit of public organizations or agencies. Through these contacts, Bureau personnel contribute their expertise and also continue to learn through their participation in and communication with these groups.

Administrative Division

Lynn Job

Division Chief

The Administrative Division includes administrative and accounting support personnel. The division is responsible for the overall administrative and fiscal management of the Bureau of Mines and Geology, and directs and administers all of the outside monies that are awarded to the Bureau of Mines and Geology for research, contracts and creative activities.

Part-Time Student Assistants

The Montana Bureau of Mines and Geology augments its staff through the employment of college students as part-time assistants. These students not only contribute to the research effort but also gain experience in organized research as part of their academic training. During all or part of the 1999–2000 biennium, 50 students from various departments were employed.

	July 1, 1998–June 30, 1999	July 1, 1999–June 30, 2000
Revenue		
General Fund Appropriation	$1,435,006.00	$1,470,263.00
Sales and Services	27,368.19	26,535.19
Other	775.09	
Ground-Water Assessment	411,477.91	600,000.00
Total Revenue	$1,873,852.10	$2,097,573.28
Expenditures		
Personnel Services	1,482,465.34	1,604,892.09
Operating Expense		
Contracted Services	144,388.46	129,323.32
Supplies and Materials	63,470.30	70,199.44
Communications	29,162.63	37,133.04
Travel	71,021.46	96,209.07
Rent	34,822.56	34,361.17
Repair and Maintenance	29,262.79	21,072.59
Miscellaneous Expense	(8,496.93)	20,192.56
Total Operations	$363,631.27	$408,491.29
Equipment	5,922.00	14,066.00
Transfer	70,000.00	70,000.00
Total Expenses	$1,922,018.61	$2,097,449.28

Analytical Division

James M. Castro

Laboratory Manager

The Analytical Division provides multi-element inorganic and organic analyses of waters, rocks, soils, sediments, and biological materials for scientists within the Montana Bureau of Mines and Geology, and for those working in other government organizations, such as the U.S. Geological Survey, the U.S. Forest Service, state and local governments, and Montana Indian tribal governments. The laboratory staff also provides technical support for research projects undertaken by faculty and students of Montana Tech and other campuses of The University of Montana and Montana State University. Staff members process over 2,000 samples annually, of which about 75% are waters and the remainder solids. The majority of the water samples are submitted for inorganic analysis; most of these are analyzed for 30 metals and 7 anions each. The remainder of the water samples and a majority of the soil samples are analyzed for organics.

Most of the water samples handled by the laboratory are ground and surface waters, and the data generated from many of them are included in the Ground-Water Information Center (GWIC) data base.

The laboratory staff consists of three scientists and two technicians.

Besides the above-mentioned analytical service work, the Analytical Division performs chemical and geochemical research. Current and recent research projects originated by the Analytical Division include (1) verification testing of an electrochemical process for removing nitrates from groundwater, (2) a study of an ultraviolet sterilization process for small water supply systems, (3) lead and copper corrosion control in small public water systems, (4) a study of dissolved copper levels in household water, and (5) development of methods for metal speciation in sediments. Division personnel also participate in projects that originate in other divisions of the Bureau.

Instrumentation currently available in the laboratory includes the following:

Inductively Coupled Argon Plasma Emission Spectrophotometer (ICAPES) — This instrument, acquired in 1997, determines 26 major cations and trace metals in water and in digests of soil or rock samples.

Inductively Coupled Plasma/Mass Spectrometer — This instrument is capable of determining over 60 trace elements at concentrations in the 1–2 parts per billion (ppb) range.

Ion Chromatographs — These two instruments are used for the determination of dissolved anions in water samples or water extracts of solid samples.

Mercury Analyzer — This instrument uses the cold vapor atomic absorption method to determine mercury in water and in digests of solids in the low ppb range.

Gas Chromatograph/Mass Spectrometer (GC/MS) — This instrument, acquired in 1996, is used to determine volatile and semi-volatile organic compounds in water and solid-sample extracts at levels below 1 ppb.

Liquid Scintillometer — This instrument is used to determine radon in water samples.

Potentiometric Titrator, Conductivity Meter, and pH Electrodes — These instruments are used to determine pH, alkalinity, and total dissolved solids in water.

During the biennium, the bulk of the Analytical Division's work was related to ground-water and environmental assessments throughout the state. Methods that conform to USGS and EPA protocol are used in the laboratory and a quality-control program maintained that includes duplicate, spike, and reference-sample analyses as part of routine analytical procedures. Staff members also participate in the semi-annual USGS Standard Reference Water Sample Program and the EPA Quarterly Reference Water Sample Program. The laboratory is certified by EPA for determination of inorganic constituents in Montana public water supplies under the supervision of the Montana Department of Public Health and Human Services and has traditionally performed well in USGS and EPA evaluation programs.

Goals and Objectives

The Analytical Division is committed to making improvements to its analytical procedures and developing new methods to serve the changing needs of its customers and keep pace with improvements in analytical technology. During the past two years, the laboratory has roughly doubled its sample throughput while adding just one full-time technician. Goals for the coming biennium include the following:

Development of cation methods for the IC to allow in-house determination of ammonium nitrogen as well as potassium, sodium, calcium, and magnesium in water samples.

Development of methods for volatile organic compounds such as methyl *tert*-butyl ether (MTBE), in water.

Development of improved methods to determine metals in soil and sediment.

Development of improved sample preparation methods, including sequential extractions, speciation methods for inorganic analytes, a purge-and-trap technique for volatile organic compounds, and automation of liquid-liquid extractions used for semi-volatile organics.

Planning for the replacement or upgrading of aging instruments.

Geocomputing Division

Patrick J. Kennelly

GIS Manager

Goal

The goal of the Geocomputing Division is to efficiently capture, analyze, and assist in the distribution of data throughout the Montana Bureau of Mines and Geology (MBMG), the State of Montana, and the world. To achieve this goal, staff members develop and maintain an electronic infrastructure, capture and convert data into electronic format, identifiy methods by which researchers can analyze and interpret these data using geographic information system (GIS) technology and assist with the dissemination of electronic data.

Electronic Infrastructure

The GeoComputing Division has made significant advances in improving the electronic infrastructure of MBMG. The two primary foci of these improvements are the MBMG network and the power of desktop PC's. The network has been upgraded within the last year, providing a ten-fold increase in data transfer efficiency within MBMG. Additionally, nearly all MBMG professionals now have desktop PC's powerful enough to efficiently use software that is graphically or computationally intensive, which facilitated the widespread use of GIS technology by MBMG professionals.

Electronic Data Conversion

The GIS Laboratory of the Geocomputing Division has strong background and experience in converting maps from paper format to electronic within strict geographic tolerances. The associated GIS data bases are also customized and populated during the data conversion. These efforts are funded by grants and contracts from state and federal government agencies, including the Montana Department of Transportation, the Montana University System Water Center, and the U.S. Geological Survey. This level of funding has more than doubled from the last biennium and shows potential for future growth. Frequent interaction and review with MBMG field mappers assures quality and accuracy of these products.

GIS Analysis

The GIS staff has begun to look at methods to distill the geographic data collected into geographic information that will be of added value to interested parties. The primary foci of this effort are to perform GIS analysis to derive non-intuitive geographic relationships and to utilize GIS for visualization of complex data. Gaining expertise in analyzing and displaying GIS data will facilitate not only earth science researchers but also assist the public in understanding issues in modeling systems of the Earth.

Electronic Data Dstribution

The demand for fast, efficient distribution of data has increased over the past two years with advances in information technology. Staff members are exploring methods to meet this challenge. Also, an internet map server application is being implemented that will allow users to query and extract MBMG data for abandoned and inactive mines using a geographical interface on the internet. This and other technologies have great potential for streamlining the process by which the public can locate and utilize MBMG data.

Information Services Division

Michael A. Coffey
Division Chief

The Montana Bureau of Mines and Geology provides extensive advisory, technical, and informational services on Montana geological, mineral, energy, and water resources to the public and private sectors; and is legislatively mandated to communicate and disseminate the findings of research conducted within the organization. It is the primary responsibility of the Information Services Division (ISD) to enable adherence to that mandate.

Goals

One of the main goals of ISD is to heighten awareness, state and nation wide, of the existence of the Montana Bureau of Mines and Geology. One way in which this is accomplished is through the release of the ever popular *Montana Geology* calendar and by attending local, regional and national conferences. The 1999 and 2000 calendars featured a snow-covered Big Horn Canyon and a water color of Pompey's Pillar by the Bureau's own, Teresa Donato, respectively. The Bureau is represented regularly at the Regional AAPG, GSA, and NWMA meetings and the National SME meeting; staff members attend the National GSA Conference when funding is available.

Customer Base

The services of this division are utilized by a diverse range of people from all over the world. Our publication sales office distributes Bureau publications and USGS topographic and thematic maps to artists (jewelers, potters, etc.); builders; geologists; local, county, state and federal agencies; miners; researchers; recreationists (amateur gold prospectors, campers, fishermen, gardeners, hikers, hunters, rock hounds, etc.); real estate agencies; students; schools; and other universities and colleges.

These materials are used for administration, exploration, earthquake tracking, genealogical studies, search and rescue, spelunking, teaching, thesis and dissertation studies, tourism, water-well potential and location, and zoning.

Division Organization

The Information Services Division comprises four sections: Editorial, Cartography, Information Systems, and Publication Sales. All sections interact daily with a variety of professionals, including but not limited to researchers, printers, publishers, state and federal agencies, and the private sector. Brief descriptions of each section are as follows.

Editorial

The editorial staff is responsible for the scientific editing, desktop publishing, typesetting, and pre-press production of a wide variety of color and monochrome publications. It is experienced in all aspects of electronic and traditional publishing, including performing all levels of editing and production, and is proficient in the latest, state-of-the-art production software. Staff members have worked extensively with research, education, and outreach publications that address such areas as mineral resources, geologic mapping, petroleum geology, risk assessment, watershed characterization, energy

education, remote sensing, GIS, and oil spill cleanup, as well as a variety of informational and promotional materials for technical and non-technical audiences. Also, the editorial staff remains abreast of the latest technical communication and writing research to better assist writers with document development and issues associated with collaborative writing.

Cartography

The cartographic staff holds over twenty-five years combined experience in the cartographic preparation of precisely registered, large multi-colored lithographs; and in the research, compilation, and design of maps, technical illustrations, scientific publications, exhibits, and presentations. It is responsible for the following tasks: (1) organization of mappable data relating to geological, mineral, and environmental investigations in Montana; (2) precise depiction and graphic design of complex, three-dimensional geological, mineral, and environmental models; (3) conceptualization and cartographic portrayal of geological, mineral, ecological, and energy data in the preparation of maps, scientific illustrations, and imagery for technical reports; and (4) use of geographic information systems and computer-aided design as well as traditional cartographic and photo-mechanical technologies to produce quality visual documents.

Information Systems

The information systems section holds our link to the outside world via the Internet. Our webmaster is required to develop, deploy, and manage the daily operation of the Bureau's World Wide Web Information System by acquiring, compiling, and maintaining graphical hypertext information; directing database maintenance activities; improving user access to the data; and creating better data distribution methods. Periodic overviews of the performance of the data system are presented to staff and management.

Publication Sales

The Bureau's sales office provides service and information via mail, phone, fax, and email. It is responsible for the Bureau's media relations and also for the dissemination of informational materials. In addition to distributing its own publications, the Bureau serves as an agent for the U.S. Geological Survey in the sale of geologic and topographic maps of Montana. Exchange materials received at the Bureau are reposited in the Montana Tech library, where they serve as a ready reference to Bureau personnel, Tech faculty, staff, and students, as well as to Montana citizens.

Earth Science Information Center

In 1983, the Montana Bureau of Mines and Geology became an affiliate of the Earth Science Information Center (E.S.I.C.). This program is part of the information branch of the National Mapping Program administered by the U.S. Geological Survey. Its mission is to help users gain better, faster, low-cost access to the cartographic holdings of federal, state and private agencies.

Through microfiche indexing, catalogues, and search systems, the Bureau assists interested persons and agencies in obtaining a variety of aerial and space imagery for the state of Montana. These coverages include Landsat imagery and the manned spacecraft photos from Apollo, Gemini, and Skylab programs.

Bureau publications are issued in the following eight categories:

Memoirs: Detailed, scientific study of a specific subject on earth science.

Bulletins: Data sources, catalogues, indexes, directories, categorized studies, and information.

Special Publications: Compilation of various works, guidebooks, proceedings volumes, bibliographies, multiple authorship; may include layperson subjects.

Miscellaneous Contributions: Administrative reports, primary data tabulations, directories, bibliographies, indexes, and catalogues.

Geologic Map Series: Mapped areas and presentations on various geologic themes; may include some descriptive text or expanded explanations; charts, tables, analytical data, etc.

Hydrogeologic Map Series: Mapped areas and presentations on various hydrogeologic themes; may include some descriptive text or expanded explanations; charts, tables, analytical data, etc.

Montana Atlas Series: Portfolio format (1º x 2º quadrangle) depicting geology, ground water, mineral resources and other subjects (when applicable).

Information Pamphlet Series: Generalized discussions of variable subject matter on earth science and general interest topics of Montana geology.

Reports of Investigation: This series is the newest in our list of publications. It is intended for brief, narrowly focused areas of study.

Open-File Reports: The open-file reports and maps are a means by which information is made available to the public on investigations that are preliminary in content, awaiting publication, or for various reasons are unpublished. Photocopies may be purchased by mail or in person.

New Publications

Special Publications

SP 113 Porter, K.W., 1999, Jurassic and Cretaceous outcrop equivalents of Shaunavon, LowerMannville, and Bow Island/Viking reservoirs, north-central Montana—A field guide.

SP 114 Stickney, M.C., Haller, K.M., and Machette, M.N., 2000, Quaternary Faults and Seismicity in Western Montana. Accompanying data base available as CD or as PDF file.

Reports of Investigation

RI 5 Wheaton, J., and Lopez, D.A., 1999, Hydrogeology of the Upper Pryor Creek Basin, Bighorn and Yellowstone counties, Montana.

RI 6 Wilde, E.M., 2000, Available coal resources of the Willow Crossing 7.5' quadrangle, Rosebud and Powder River counties, Montana.

RI 7 Metesh, J.J., English, A., Lonn, J., Kendy, E., and Parrett, C., 1999, Hydrogeology of the upper Soda Butte Creek basin, Montana.

RI 8 Metesh, J.J., 1999, Yellowstone National Park controlled ground-water area, Montana—Well inventory and baseline symetry.

RI 9 Lopez, D.A., 2000, Greybull Sandstone petroleum potential on the Crow Indian Reservation of south-central Montana.

Geologic Map Series

GM 56 Vuke, S.M., Wilde, E.M., Lopez, D.A., and Bergantino, R.N., 2000, Geologic map of the Lodge Grass 30' x 60' quadrangle, Montana.

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GM 58 Lopez, D.A., 2000, Geologic map of the Bridger 30' x 60' quadrangle, Montana.

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GWAA 1 Part B—Maps only, 1999.

Map 1 Smith, L.N., 1999, Geologic framework of hydrologic units in the Lower Yellowstone River area: Dawson, Fallon, Prairie, Richland, and Wibaux counties, Montana (1998).

Map 2 Smith, L.N., 1999, Thickness of unconsolidated deposits, Lower Yellowstone River area: Dawson, Fallon, Prairie, Richland, and Wibaux counties, Montana (1998).

Map 3 Smith, L.N., 1999, Thickness of the Fox Hills–lower Hell Creek aquifer, Lower Yellowstone River area: Dawson, Fallon, Prairie, Richland, and Wibaux counties, Montana (1998).

Map 4 Smith, L.N., 1999, Depth to the Upper Cretaceous Fox Hills–lower Hell Creek aquifer, Lower Yellowstone River area: Dawson, Fallon, Prairie, Richland, and Wibaux counties, Montana (1997).

Map 5 Patton, T.W., Rose, J.C., LaFave, J.I., and Smith, L.N., 1999, Potentiometric surface map for the Shallow Hydrologic Unit Lower Yellowstone River Area: Dawson, Fallon, Prairie, Richland, and Wibaux counties, Montana (1998).

Map 6 LaFave, J.I., 1999, Potentiometric surface map for the Deep Hydrologic Unit, Lower Yellowstone River area: Dawson, Fallon, Prairie, Richland, and Wibaux counties, Montana (1998).

Map 7 LaFave, J.I., 1999, Potentiometric surface map of the Fox Hills–lower Hell Creek aquifer, Lower Yellowstone River area: Dawson, Fallon, Prairie, Richland, and Wibaux counties, Montana (1998).

Map 8 LaFave, J.I., and Patton, T.W., 1999, Dissolved constituents map for the Shallow Hydrologic Unit, Lower Yellowstone River area: Dawson, Fallon, Prairie, Richland, and Wibaux counties, Montana (1998).

Map 9 LaFave, J.I., 1999, Dissolved constituents map of the Deep Hydrologic Unit, Lower Yellowstone River area: Dawson, Fallon, Prairie, Richland, and Wibaux counties, Montana (1998).

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